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SAVANNAH RIVER STUDIES, JULY 1951 - JULY 1952

D. D. Gold, et al

Robert A. Taft Sanitary Engineering Center
Cincinnati, Ohio

April 1954

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INTERIM REPORT

ON THE

SAVANNAH RIVER STUDIES

July 1951 - July 1952

by

D. D. Gold
D. C. Scott
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Cincinnati, Ohio
April 1954

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TABLE OF CONTENTS

Page

LIST OF CONTRIBUTORS 1

ACKNOWLEDGMENTS ii

CHAPTER I

SUMMARY OF FINDINGS AND RECOMMENDATIONS 1

FINDINGS AND CONCLUSIONS 1
RECOMMENDATIONS 6

CHAPTER II

GENERAL INFORMATION 10

OBJECTIVES 10
INITIATION OF STUDIES 11
SAMPLING PROGRAM 12
LOCATION BY RIVER MILES OF SAMPLING STATIONS, LANDINGS, TRIBUTARIES, ETC. 13
LABORATORY ACTIVITIES 18
SPECIAL STUDIES 19

CHAPTER III

GENERAL DESCRIPTION 21

THE SAVANNAH RIVER BASIN 21
TOPOGRAPHY AND GEOLOGY (Clark Hill Dam to Atlantic Ocean) . . 21
POPULATION 23
LAND USE 23
WATER USE AND DEVELOPMENT 23
Fish and Wildlife 23
Recreation 24
Reservoirs and Diversion Projects 24
Clark Hill 24
Proposed Dams and Reservoirs 25
Diversion of Savannah River Water 26
Navigation 26
Water Supplies 26
Sources of Pollution 27
Domestic Sewage 27
Industrial Wastes 29

CHAPTER IV

Page

STREAM FLOWS 33

DISCHARGE DATA 33
Savannah River at Augusta, Georgia 33
Savannah River at Burtons Ferry Bridge 33
Savannah River Near Clyo 34
Augusta Canal Near Augusta, Georgia 34
Briar Creek at Millhaven, Georgia 34

CHAPTER V

CHEMICAL, BACTERIOLOGICAL AND PHYSICAL STUDIES 37

WATER QUALITY 38
Dissolved Oxygen 38
Biochemical Oxygen Demand 38
Coliform MPN 39
Minerals 39
Turbidity 43
Color 43

SPECIAL STUDIES 44
Dissolved Oxygen and Salinity Studies in the Savannah River Estuary 44

Study of Sludge Bank in Lower Savannah River Section, S-14 to S-8 46

Clark Hill Reservoir Studies 58

SAVANNAH RIVER WATER TEMPERATURE IN AUGUSTA CANAL AT AUGUSTA, GEORGIA 71

CHAPTER VI

BIOLOGICAL STUDIES 74

FRESHWATER ENVIRONMENTAL ASSOCIATIONS 74
Plankton 76
Benthos 83
Benthic Algal Growths and Associated Organisms 83
Organisms Associated with Compact Clay. 96
Organisms Associated with Sand and Mud. 100
Organisms Associated with Brush, Trees, Rocks, Gravel, etc. 106

Nekton 116

Page

COMMERCIAL AND SPORT FISHING 116
Commercial Fishing 116
Basket Fishing for Catfish 117
Shad Fishing 118
Sport Fishing 124

SEINE AND NET SAMPLING 125
Hoop Netting 125
Gill Netting 130
Seining 130

ROTENONE SAMPLING 131
AGE AND GROWTH DETERMINATIONS 134
FISH MOVEMENT STUDIES 137
ANNOTATED LIST OF FRESH WATER FISHES 138
ESTUARINE STUDIES 157

CHAPTER VII

BACKGROUND RADIOACTIVITY OF WATER AND BIOTA 160

RADIOACTIVITY OF WATER 161
RADIOACTIVITY OF FRESH WATER BIOTA 163
RADIOACTIVITY OF ESTUARINE BIOTA 163
MINIMUM DETECTABLE RADIOACTIVITY 165

- - - - - - -

APPENDICES

APPENDIX "A"

SUMMARY OF INDIVIDUAL RESULTS - SANITARY EXAMINATIONS
S-230.7 - S-218.5 177
S-218.5 - S-217.2;HGG 0.01 178
S-217.2;HGG 0.01 - S-213.36;Ho 0.01 179
S-212.0 180
S-203.3 - S-202.9 181
S-202.65;Bu 0.02 - S-202.65;Bu 2.2 182
S-202.65;Bu 2.2 - S-201.65 183
S-201.65 - S-197.0 184
S-197.0 - S-182.0 185
S-177.0 - S-172.0 186
S-172.0 - S-167.0 187
S-164.26;Fo 0.01 - S-157.0 188
S-155.2;St 0.01 - S-152.0 189
S-152.0 - S-137.32;LTR 0.01 190
S-132.0 - S-105.0;Bl 0.2 191

Page

S-102.0 - S-52.0 192
S-52.0 - S-32.0 193
S-11.0 194

APPENDIX "B"

SUMMARY OF INDIVIDUAL RESULTS - MINERAL EXAMINATIONS
S-218.5 - S-164.26;Fo 0.01 197
S-155.2;St 0.01 - S-11 198

APPENDIX "C"

CLARK HILL RESERVOIR - SUMMARY OF INDIVIDUAL RESULTS - IRON, MANGANESE, TEMPERATURE, TURBIDITY AND DISSOLVED OXYGEN DETERMINATIONS; RESERVOIR DISCHARGE DATA

S-255
Ga.Hwy. #43 Bridge over Savannah River
4/30/52 - 5/22/52 201

S-253, Li(S.C.)-3.2
S.C.Hwy. #43 Bridge over Little River, S.C.
4/30/52 - 5/22/52 202

S-246
8 miles above Dam - 5/6/52 - 5/21/52 203

S-239.1, Li(Ga)-9
Ga.Hwy.#47 Bridge over Little River, Ga.
4/30/52 - 5/22/52 204

S-239.1
1 mile above Dam - Junction of Little River, Ga. with Savannah River
3/10/52 - 5/1/52 205

S-239.1
1 mile above Dam - Junction of Little River, Ga. with Savannah River
5/3/52 206

S-239.1
1 mile above Dam - Junction of Little River, Ga. with Savannah River
5/21/52 - 5/26/52 207

Page

S-239.1
1 mile above Dam - Junction of Little River, Ga.
with Savannah River
6/13/52 208

PROVISIONAL DATA
S-237.8
0.3 mile below Clark Hill Dam.
Sample taken from construction bridge below the dam . . 209
5/26/52

APPENDIX "D"

SUMMARY OF INDIVIDUAL ANALYTICAL RESULTS FOR THE
SAVANNAH RIVER SECTION - S-23 to S-0

S-23 to S-2 - March 28, 1952 212
S-23 to S-0 - June 23, 1952 213

APPENDIX "E"

DESCRIPTION OF THE PROCEDURE USED FOR ASSAYING THE
RADIOACTIVITY IN FRESH WATER AND FOR BIOTA

FRESH WATER PROCEDURE 217
Suspended Solids 217
Dissolved Solids 217

BIOTA PROCEDURE 218
Fish Flesh 218
Fish Bone 219
Brush Box Organisms and Algae 220

APPENDIX "F"

CHEMICAL METHODS OF WATER ANALYSIS

MANGANESE - COLORIMETRIC DETERMINATION 223
Apparatus 223
Reagents 223
Preparation of Sample 224
Procedure 224
Calculations 225

Page

IRON - COLORIMETRIC DETERMINATION
PHENANTHROLINE METHOD 225

Apparatus 225
Reagents 225
Preparation of Sample 226
Procedure 226
Calculations 226
Suggested Standards 227
Notes and Comments

APPENDIX "G"

BIOLOGICAL METHODS AND TABLE - (COMPLETE LIST OF ORGANISMS FOUND IN BRUSH BOX SAMPLES)

PLANKTON COLLECTION AND COUNTING METHODS 231

BOTTOM ORGANISM COLLECTION METHODS 231
Petersen Dredge 231
Brush Boxes 232

TABLE I - COMPLETE LIST OF ORGANISMS FOUND IN BRUSH BOX SAMPLES 236

LIST OF TABLES

Table No.		Page
1.	Daily Average Savannah River Discharge in cfs for period July 1, 1951 to June 30, 1952	30
2.	Average, Maximum and Minimum Daily Discharges in cfs for period July 1, 1951 to June 30, 1952	36
3.	Chemical Analysis of Sludge Samples from S-11 and S-14	57
4.	Analytical Data on Samples taken May 26, 1952 from S-239.1, Clark Hill Reservoir	60
5.	Turbidity Values on Samples taken at S-239.1 on March 31 and May 6, 1952	71
6.	Clark Hill Reservoir and Savannah River Net Plankton Organisms per Liter - April 1952	78
7.	Clark Hill Reservoir and Savannah River Net Plankton Organisms per Liter - May 1952	80
8.	Clark Hill Reservoir and Savannah River Nannoplankton Organisms per 10 Milliliters - May 1952	84
9.	Clark Hill Reservoir and Savannah River Total Phytoplankton Organisms per Liter - May 1953	85
10.	Organisms Found in Clark Hill Reservoir and Savannah River Plankton - April-May 1952	86
11.	Algal-Mass Algae	90
12.	Animals Associated with Algal Masses	92
13.	Quantitative Clay Bank Sample S-52.0 - July 30, 1952.	99
14.	Bottom Samples. - Summary	102
15.	Brush Box Sampling - Summary	110
16.	Basket Fishery - Commercial Catches Examined	126
17.	Shad Fishery - Commercial Catches Examined	127
18.	Composition of Hoop Net Catches - S-172.5 - S-140.0, December 3, 1952 - July 12, 1952	128

Table No.		Page
19.	Comparison of Hoop Net and Commercial Catches	129
20.	Results of Catfish Marking Experiment - May 8 - July 12, 1952	139
21.	Results of Rotenone Sampling	140
22.	Estuarine Sampling - April 22-24, 1952 - Analytical Results	153
23.	Estuarine Collections, April 1954	154
24.	Radioactivity of Savannah River Water Samples	166
25.	Radioactivity of Fresh Water Fish - 1951-1952 . . .	167
26.	Radioactivity of Fresh Water Minnows and Algae - 1951-1952	169
27.	Radioactivity of Fresh Water Brush Box Organisms - 1951-1952	170
28.	Radioactivity of Crabs, Oysters and Shrimp found in Savannah River Estuaries April 1952	171
29.	Radioactivity of Fish found in the Savannah River Estuaries April 22-24, 1952	172
30.	The Maximum Radioactive Density of the Savannah River Samples - 1951-1952	174

LIST OF FIGURES

Figure No.		
1.	Map of Savannah River - Sampling Locations, Clark Hill Dam to Mouth	15
2.	Flow Investigation - Abercorn Creek, Effingham County, Georgia	31
3.	Dissolved Oxygen - Mean and Minimum	41
4.	Biochemical Oxygen Demand, 5-day @ 20°C - Mean and Maximum	41
5.	Coliform MPN per 100 ml. - Mean, Maximum and Minimum	41

Figure No.		Page
6.	Savannah River Estuary - Location of Sampling Stations	47
7.	Dissolved Oxygen - High Tide - March 28, 1952	49
8.	M. O. Alkalinity (ppm), % Seawater, - High Tide - March 28, 1952	49
9.	Dissolved Oxygen - Between Mean and High Tide - March 28, 1952	49
10.	Per cent Seawater - Between Mean and High Tide - March 28, 1952	49
11.	Dissolved Oxygen - Mean Tide - March 28, 1952	51
12.	Per cent Seawater - Mean Tide - March 28, 1952 . . .	51
13.	Dissolved Oxygen - Low Tide - March 28, 1952	51
14.	M. O. Alkalinity (ppm), % Seawater, - Low Tide - March 28, 1952	51
15.	Dissolved Oxygen, Surface Samples - High and Low Tide - June 23, 1952	53
16.	Dissolved Oxygen, Bottom Samples - High and Low Tide - June 23, 1952	53
17.	Dissolved Oxygen, Bottom and Surface Samples - High Tide - June 23, 1952	53
18.	Dissolved Oxygen, Bottom and Surface Samples - Low Tide - June 23, 1952	53
19.	Chlorides - % Seawater - High and Low Tide - June 23, 1952	55
20.	Clark Hill Reservoir Sample Station Location Map . .	61
21.	Dissolved Oxygen - Depth Relation (1952) Clark Hill Reservoir - March 10, March 31, May 1 and May 3	63
22.	Dissolved Oxygen - Depth Relation (1952) Clark Hill Reservoir - May 6	63
23.	Dissolved Oxygen - Depth Relation (1952) Clark Hill Reservoir - May 13, May 21, May 26	63

Figure No.		Page
24.	Dissolved Oxygen - Depth Relation (1952) Clark Hill Reservoir - June 13, July 28	63
25.	Daily Average Water Temperature of Augusta Canal, and Daily Flow of Savannah River - January 22, 1951 - January 21, 1952	65
26.	Comparison of Air and Water Temperatures, Augusta Canal - February 4, 1951 - February 3, 1952	67
27.	Distribution of Water Temperature - Augusta Water Intake - February 4, 1951 - February 3, 1952	69
28.	Length-Frequency Distribution - Channel Catfish - August 1951 - May 1952	119
29.	Length-Frequency Distribution - White Catfish - August 1951 - July 1952	121
30.	Length-Frequency Distribution - Flat Bullheads - June 1951 - July 1952	121
31.	Length-Frequency Distribution - American and Hickory Shad - February-April 1952	143
32.	Length-Frequency Distribution - Silvery Minnow - May 14 - July 3, 1952	145
33.	Length-Frequency Distribution - Spottail Shiner . . .	145
34.	Length-Frequency Distribution - Pirate Perch	145
35.	Length-Frequency Distribution - Bluegill - May-July 1952	147

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CHAPTER I

SUMMARY OF FINDINGS AND RECOMMENDATIONS

This study of the Savannah River extended from July 1951 into July of 1952. Most of the work was confined to the area just downstream (mile 230.7) from Clark Hill Dam to the river's mouth (mile 0.0). Situated in this reach of the Savannah River is the tract of land that was selected for the Savannah River plant of the Atomic Energy Commission. This tract comprises 250,000 acres in Aiken, Allendale and Barnwell Counties, South Carolina, about 25 miles downstream from Augusta, Georgia. Data were gathered for the most part before the impoundment of the Savannah River by Clark Hill Dam.

The principal objectives of the survey were to determine: (a) the water quality characteristics of the stream, (b) the background radioactivity of water and biota and (c) the ecology of the biota and its economic importance before initiation of operations at the Savannah River plant of the Atomic Energy Commission and before impoundment of water by Clark Hill Dam.

FINDINGS AND CONCLUSIONS

The findings and conclusions reached are as follows:

1. Savannah River water is soft and low in mineral content throughout the year except for the estuarine section of the river which is mixed with sea water.
2. For almost 20 per cent of the days, or more than 60 days between February 4, 1951 to February 3, 1952, the water temperature

at the Augusta Water Intake was in the 82° to 86° F. temperature range. For less than ten days the water temperature was between 62° to 66° F. There were only nine days in the 38° to 42° F. temperature range.

3. The red muddy appearance of the Savannah River, which gives the illusion of high turbidity, is caused by colloidal red clay. The water on examination in the laboratory is not nearly as turbid as the stream appearance suggests, since the colloid affects "apparent color" rather than turbidity. The minimum mean turbidity value for all the Savannah River samples was 62 ppm and the maximum mean turbidity value was 115 ppm at the various stations. Single turbidity values ranged from a minimum of 8 ppm to 440 ppm.

4. Thirty-two water samples from seven Savannah River sampling stations and four tributaries were analyzed for the gross alpha and beta radioactivity associated with the suspended solids (insoluble) and in solution (soluble). The insoluble alpha activity varies from zero to a maximum of 4.1 $\pm$ 1.7 micromicrocuries per liter of water. The soluble alpha activity of the sample showing the maximum insoluble activity was 0.1 $\pm$ 1.1 μμc/liter. Thus the total alpha activity was 4.2 $\pm$ 2.0 μμc/liter of water. Usually there was more insoluble than soluble alpha activity in the samples. However, in six out of 31 samples the soluble alpha activity exceeded the insoluble activity. The maximum soluble alpha activity was 8.4 $\pm$ 2.1 μμc/l. compared to an insoluble alpha activity of 0.4 μμc/l.

5. The beta activity was appreciably higher in magnitude than the alpha activity. This is particularly true with respect to soluble activity. Thus the maximum soluble beta activity was 31.8 ± 14.8 μμc/l. This sample had an insoluble beta activity of only 8.6 ± 5.1 μμc/l. The maximum total beta activity occurred for this sample and was 40.4 ± 15.6 μμc/l.

6. Radioactive measurements were determined on 61 fresh water biological samples. These samples consisted of 40 individual or composite flesh and bony tissue samples, and composite samples of whole fish minnows, 7 samples of brush box organisms (largely insect larvae), and 7 samples of algae. The statistically significant results showed that the radioactivity of all samples exclusive of fish bone was 47 ± 28 μμc or less of alpha activity and 14.3 ± 5.6 μμc or less of beta activity per gram of wet weight sample. The minnows (whole fish samples) and the insect larvae, all of which samples probably contained soil, showed a significant alpha activity. The maximum alpha activity of fish flesh was 1.5 ± 0.9 μμc/gram. The radioactivity of the ash of fish bone was less than the statistical error of the determination which varied from ±2 to ±28 μμc/gram for the alpha activity and ±20 to ±260 μμc/gram for beta activity. The algae showed no significant amount of alpha activity but a measurable beta activity.

7. Radioactive analyses were made on samples of flesh of estuarine animals, which included: 9 composite samples of crabs, 8 of shrimps, 2 of oysters, and 32 of fishes; and the bone or shell of 17 composite samples from various organisms. The maximum alpha activity in muscular tissues was 0.22 $\pm$ 0.17 $\mu\mu c/g$. in an oyster sample. All but one composite flesh sample had a small but significant beta activity which may be attributed to K^{40}. The beta activity varied from 0.5 $\pm$ to 0.2 $\mu\mu c/g$. in an oyster sample to 4.5 $\pm$ 1.1 $\mu\mu c/g$. in a fish sample.

8. Plankton populations in the Savannah River were quite low. They did not appear to be significantly influenced by the plankton which developed in the Clark Hill Reservoir or by the organic enrichment afforded by Augusta sewage. Some plankton organisms, particularly diatoms, appeared either to multiply in the river itself or to be added to the river from backwater areas. The general paucity of river plankton can probably be attributed to the scarcity of inorganic nutrients and the low transparancy of the water. If sedimentation in Clark Hill Reservoir results in some clarification of the river water, the plankton populations of the river may be expected to increase.

9. Benthic algal growths and their associated organisms formed transient communities of seasonal importance. These could only maintain themselves when river levels remained constant

over periods of several weeks or when they were formed on substrates which could rise and fall with the water. Such communities of algae, herbivores and carnivores might well become of much greater importance if stable water levels and clearer waters prevail over considerable parts of the year.

10. The hard clay banks which form a large part of the river's edge supported dense populations of nymphs of burrowing mayflies (Tortopus). These insects and the organisms associated with them formed an important part of the biota of the river.

11. The sand and mud of the river bottom proper, the most abundant substrates available to benthic organisms, supported the most sparse populations. Much of this bottom material was in an unstable condition which prevented the establishment of most bottom organisms. In areas of strong current, these materials were constantly shifting, while in still waters the bottom was constantly subjected to siltation. The organic enrichment supplied by Augusta sewage provided a habitat for the development of a fauna of pollution tolerant forms immediately below the mouth of Butler Creek. General observations, at periods of low water, indicated that mussels were important constituents of the benthic fauna.

12. Wherever stable substrates, organic or inorganic in nature, were present in the river current, a diverse population of organisms became established. Since the river was abundantly provided with such substrates in the form of brush, trees,

roots, etc., such habitats were considered to be among the most important encountered. Organisms that were found in them consisted largely of detritus feeders and carnivores.

13. Commercial fishing on the Savannah River was quite limited in extent. A small basket fishery for channel catfish and a small seasonal gill net fishery for shad were established. Although it was not possible to assess the absolute value of these fisheries, they were obviously of negligible economic importance to the surrounding region. Sport fishing while indulged in by a few enthusiasts was of little importance on the river. Tributaries and the flood plain lakes were apparently more heavily fished.

14. The fish population of the Savannah River was typical for a muddy river of the southeast Atlantic Coast. The channel catfish was one of the most important constituents of the population. Two other catfish were also abundant, the white catfish and the flat bullhead. Suckers were moderately abundant, as were carp. A number of forage minnows was present. Among the spiny-rayed fish the sunfishes, largemouth bass and both black and white crappies were all present in moderate numbers. The American and hickory shads and the striped bass were the most important anadromous fishes to utilize the river. A total of 60 species of fish known to occur in fresh waters of the Savannah River are reported here.

15. With the exception of the Savannah Harbor proper, which is degraded from a combination of pollution and silt, the estuarine waters around the mouth of the river are quite typical of this stretch of coast. Shrimp and crabs are taken commercially in the immediate vicinity of the river mouth. Sport fishing for various estuarine fishes is also of considerable importance in this area. Oysters, while abundant at the river mouth, are contaminated by sanitary wastes and are not utilized.

16. Raw sewage from Augusta, Georgia, is discharged into Beaver Dam Ditch where it receives some natural treatment when the Ditch passes through Phinizy swamp to join Butler Creek, about 300 yards above the confluence of Butler Creek and Savannah River. Even in the summer months during low flow there was sufficient dilution of swamp treated Augusta sewage so that but little oxygen depletion occurred in the Savannah River below Augusta, Georgia.

17. During this period of the studies the sewered population was about 3500 persons in North Augusta, South Carolina. The Savannah River, at low flow, affords sufficient dilution so that little effect is noticed on the oxygen resources of the river.

18. The Savannah River downstream from Savannah, Georgia, is sometimes entirely depleted of its dissolved oxygen content, which results in an "oxygen block" to fish during the summer months. Domestic pollution from the city of Savannah, Georgia, and

industrial pollution from paper and pulp mills located on the Georgia side of the river above Savannah are important factors in the depletion of dissolved oxygen in the river below Savannah, Georgia. There are extensive mobile sludge banks up to 12 feet in depth in the Savannah River section, between mile 20 to mile 3. These sludge banks contain from 10 to 30 per cent volatile matter on a dry weight basis.

RECOMMENDATIONS

The observations and findings from these studies indicate a need for continued or new work, as follows:

1. Efforts should be made to determine the effect the Atomic Energy Commission's Savannah River Plant may have on the radioactivity of the Savannah River waters and its biota.
2. Possible increases in water temperature with the addition of quantities of heat from cooling waters released by the Savannah River plant may be either beneficial or detrimental to the total biota of the river immediately below the plant outfall. The effects of increased river water temperature on the biota in the river should be studied.
3. Impoundment of Savannah River water by Clark Hill Dam may induce appreciable changes in water quality and quantitative as well as qualitative changes in river biota. Studies should be performed to ascertain such changes, since the quality of the Savannah River water is of vital importance to industries and municipalities as a source of water supply.

4. Public concern and apprehension regarding waters which receive cooling water and/or waste discharge from atomic energy plants necessitate that a record of studies by an agency other than the Atomic Energy Plant or Operations Management should be available for informational use by State Health Departments and other agencies of government. Continuing short studies at reasonable intervals are desirable to satisfy the need for protecting public welfare and public relations.

5. More accurate as well as more simplified radiochemical analytical techniques and counting equipment are needed for determining low levels of radioactivity.

6. Studies of a research nature are needed to develop information relating to (1) - the effect of silt load in rivers upon adsorption of radioactive substances, (2) - radioactive adsorption characteristics of various types of silt commonly present in rivers, and (3) - the effect of river eddies and currents on time-distance relations of silt load deposition.

CHAPTER II

GENERAL INFORMATION

The Savannah River studies were planned and every effort made to conduct them in such a manner as to meet the needs and responsibilities of the States involved, the Atomic Energy Commission, and the Public Health Service. Because the river is vital to the operations of the Savannah River plant of the Atomic Energy Commission, and serves as a source of water supply for the city of Augusta and as a partial source of water supply for the city of Savannah, it is important to have a full knowledge of the river and its changing characteristics.

OBJECTIVES

The main objectives of the Public Health Service program were as follows:

1. To determine hydrological, physical, chemical, radiological and biological characteristics of the Savannah River above and below the Atomic Energy Commission's Savannah River plant, including the area above and below Clark Hill Dam.
2. To develop new and to improve existing techniques as applied to stream sanitation objectives.
3. To establish the biological conditions prevailing in the Savannah River so that future changes resulting from impoundment behind Clark Hill Dam, operation of the Atomic

Energy Commission's Savannah River plant and attendant increased population can be detected and measured.

4. To determine the relative abundance of the various species of fish in the river and the extent to which they were being utilized for sport or commercial purposes.

A comparison of the results of future investigations with those of the present one should permit the detection and evaluation of the environmental changes caused by anticipated activities in the Savannah River watershed.

INITIATION OF STUDIES

In July 1951, the Surgeon General of the U. S. Public Health Service formed the Savannah River Studies Advisory Board by appointing representatives from the States of Georgia and South Carolina, the E. I. DuPont de Nemours and Company, the Atomic Energy Commission, the U. S. Army Corps of Engineers, the U. S. Geological Survey, and the U. S. Public Health Service to the status of Board Members. The function of the Savannah River Studies Advisory Board is to review the data obtained by the survey group and to aid in planning continuing studies on the Savannah River.

The field work of the Savannah River Studies' program was initiated on July 1, 1951, with the basing of two mobile laboratory units in the Georgia National Guard area in Augusta, Georgia. By the end of July conversion of a building in the area into a laboratory was completed and operations were transferred from the mobile units to the building.

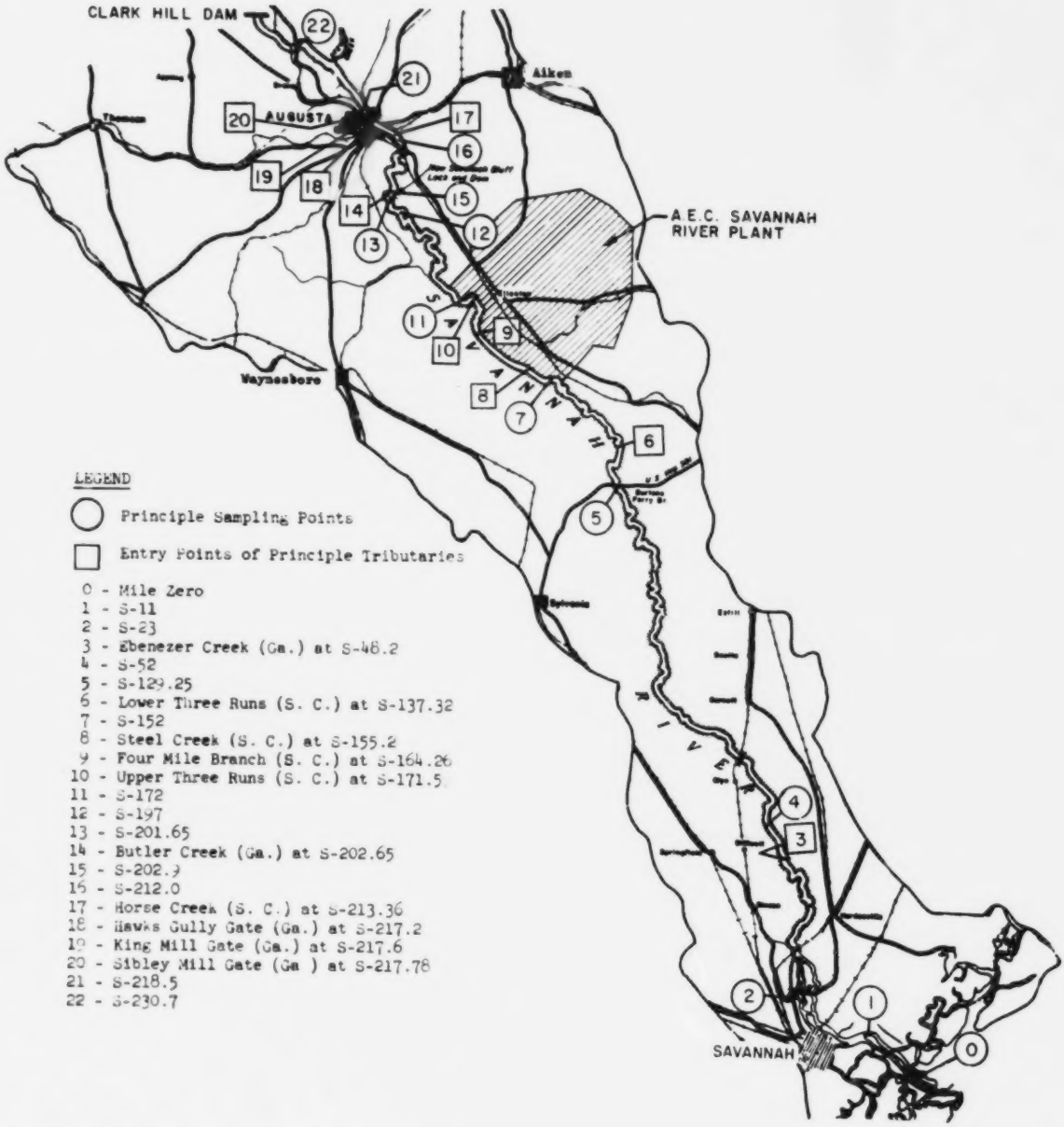
SAMPLING PROGRAM

A mileage index system, listed below, was used to identify the location of sampling stations, landings and other important points on the Savannah River and its tributaries. This system involves the use of one or more letters to identify the stream, followed by a number which represents the distance in river miles from the mouth. On the Savannah River, the letter "S" designates the stream. On the tributaries the first and second letters of the name of the stream are used to designate the stream, with the exception of Upper Three Runs and Lower Three Runs for which the three letters "UTR" and "LTR" are used, respectively. The first and second letters of the tributaries are preceded with the notation, "S- confluence mile." For example, the sampling station on Steel Creek would be designated on the mileage index system as S-155.2, St.-.01. This indicates that the station is located on Steel Creek .01 mile from its confluence with the Savannah River and the confluence is 155.2 miles from the mouth of the Savannah River. If there were two Steel Creeks, one in Georgia and one in South Carolina, the stream designation would have been followed by the abbreviation of the name of the State in which it was flowing, e.g., Steel Creek in South Carolina would be designated as S-155.2, St(S.C.)-.01.

LOCATION BY RIVER MILES OF SAMPLING STATIONS, LANDINGS, TRIBUTARIES, ETC.

S-246	Sample Station in Clark Hill Reservoir, 8 miles above Dam
S-239.1	Sample Station at confluence of Little River with Savannah River
S-238.1	Clark Hill Dam
S-230.7	Woodlawn Landing (Railroad Bridge), S. C.
S-218.5	Sample Station just above Rae's Creek, Ga.
S-217.8	Sibley Mill Gate, Ga.
S-217.6	King Mill Gate, Ga.
S-217.2	Hawks Gully Gate, Ga.
S-216.5	North Augusta
S-216.0	Augusta
S-215.79	Southern Railway Bridge
S-215.64	Fifth Street Bridge (USGS Alternate Gage)
S-215.6	Fifth Street Landing, Ga.
S-213.36	Horse Creek, S. C.
S-212.0	Sample Station 1/4 mile above Sand Bar Ferry Road Bridge
S-211.73	Sand Bar Ferry Road Bridge
S-211.38	C & W C Railway Bridge
S-202.97	New Savannah Bluff Lock and Dam
S-202.9	Sample Station just below New Savannah Bluff Lock and Dam
S-202.65	Butler Creek, Ga. (USGS Augusta Gage)
S-201.65	1 mile below Butler Creek
S-198.95	Thomas Creek, Ga.
S-198.42	Spirit Creek, Ga.
S-197.0	Sample Station
S-191.8	Hollow Creek, S. C.
S-189.4	Silver Bluff Landing, S.C. (Good landing and access road)
S-186.57	Bridge Creek, Ga.
S-178.57	McBean Creek, Ga.
S-176.66	Boggy Gut Creek, Ga.
S-176.4	Shell Bluff Landing, Ga.
S-172.0	Sample Station
S-171.59	Upper Three Runs, S. C.
S-165.55	Hancock Landing, Ga. (Good landing with boom & winch, access road)
S-164.26	Fourmile Branch, S. C.
S-161.98	Joblers Creek, Ga.
S-157.3	Brighams Landing, Ga. (Good landing and access road)
S-155.2	Steel Creek, S. C.
S-152.0	Sample Station
S-146.4	Entrance to Dead River (Little Hell Landing), S. C.
S-145.38	Sweetwater Creek, Ga.
S-144.65	Stony Bluff Landing, Ga. (Good landing and access road)
S-137.32	Lower Three Runs, S. C.
S-131.27	Rocky Creek, Ga.
S-129.25	Highway 301 Bridge (Burton's Ferry Bridge, USGS Gage)

S-128.23	Brier Creek, S. C.
S-124.76	Swift Creek, Ga.
S-113.7	Cohens Bluff Landing, S. C.
S-106.8	Swift Creek, Ga.
S-105.5	Brier Creek and Landing, Ga.
S-98.93	Buck Creek, Ga.
S-91.7	Poor Robin Landing, Ga.
S-82.53	Black Creek, Ga.
S-82.19	Blue Springs Creek, Ga.
S-81.2	Hudsons Ferry, Ga.
S-68.0	Bostick and Stokes Landing, S. C.
S-64.9888	S.A.L. Railway Bridge (USGS Clyo Gage)
S-52.0	Sample Station
S-48.2	Ebenezer Creek, Ga.
S-48.1	Ebenezer Landing, Ga.
S-46.33	Lockner Creek, Ga.
S-44.74	Mill Creek, Ga.
S-43.24	Big Collis Creek, Ga.
S-42.4	Bear Creek, Ga.
S-36.2	Purysburg, S. C.
S-29.83	Big Collis Creek, Ga.
S-27.36	A.C.L. Railway Bridge
S-22.0	Highway Bridge Landing (Hy.17); Wild Life Lndg. on Back River, S.C.
S-16.5	Seaboard RR Bridge
S-14.5	Foot of Bull St., Ga. (Corps of Engineers Dock & Laboratory)
S-11.0	Sample Station 1/4 mile below Fort Jackson
S- 0.5	Old Quarantine Station, Cockspur Island
S- 0.0	Vicinity of Fort Pulaski



SAVANNAH RIVER

CLARK HILL DAM TO MOUTH

FIG.I

The survey group concentrated on the following stations: S-218.5; S-202.9; S-197; S-172; S-152; S-11 and four creeks, namely, S-164.26, Wo-.01; S-155.2, St-.01; S-151.29, UTR-.01 and S-137.32, LTR-5.75. Other sampling stations were used occasionally for chemical, bacteriological and biological samples. Samples were taken at 1/3, 1/4, or 1/2 points across the river for bacteriological determinations. In the early stages of the survey, samples for chemical determinations were taken at 1/3, 1/4, or 1/2 points across the river at sample stations, but this practice was discontinued when the chemical determinations showed no variation in such sampling. Samples for chemical determinations were subsequently taken in mid-stream at sampling locations.

Routine mineral analyses were performed at the Augusta laboratory on the same sampling schedule as for samples sent to the Environmental Health Center laboratory at Cincinnati.

Sampling for radiological background and spectrographic analysis was discontinued April 10, 1952 when it was apparent that sufficient samples for background radioactivity had been obtained.

Biological sampling stations were selected in the vicinity of the chemical and bacteriological sampling stations, where practicable. However, because the location of organism concentrations is dependent upon various river features such as bars, velocity, currents, depth, etc., the selection of biological sampling stations was primarily governed by these features.

Sampling was conducted to secure a representative portion of water at each sampling station. The sample was drawn from midstream at a depth of three feet. A copper depth sampler, which held special bottles for dissolved oxygen and bacteriological samples, was used. When water samples for only bacteriological determinations at 1/4 or 1/3 points across the stream were collected, a pole-type dip sampler holding a sterile bottle was used. A Kemmerer bottle was used to obtain water samples for chemical and physical analyses in the deep waters in Clark Hill Reservoir and in the lower Savannah River.

Samples were transported in special ice chests from the sample locations to the laboratory. The ice chests were of such construction that no sample was in direct contact with the ice. The bottles containing water samples were supported in an upright position in the ice chest. The samples were brought to the laboratory as quickly as possible so that analyses could be initiated with a minimum elapsed time.

LABORATORY ACTIVITIES

During the early stages of the studies, chemical and bacteriological determinations were performed in two mobile trailer units. Later, laboratory facilities were constructed in a building in the National Guard area at No. 1 Milledge Road, Augusta, Georgia. The arrangements for the use of this building were made through the Georgia Department of Public Health. Laboratory operations were transferred from the trailer units to the building during September 1951. The Savannah River studies group was also granted the use of a large brick building for repair and storage facilities and two open walled sheds for drying fish nets and for gasoline storage.

The Corps of Engineers, Savannah District, furnished the Savannah River studies group the use of facilities in their laboratory located on their dock at the foot of Bull Street in Savannah. They also made available the use of their dock and boat launching equipment for sample collection activities.

Facilities suitable for a field laboratory were made available by personnel attached to the Fort Pulaski National Monument on Cockspur Island.

A total of 490 water samples from the Savannah River and tributary streams was taken for routine chemical and physical analysis on which 4,014 determinations were performed; 603 water samples were collected for bacteriological analysis and 603 determinations were performed. In addition, 32 water samples were shipped to the Environmental Health Center laboratories in Cincinnati, Ohio, for radioactive background counts and spectrographic analysis. A total of 38 water samples was taken for mineral analysis, on which a total of 582 determinations were performed. Numerous other samples were collected for dissolved oxygen and salinity studies in the lower Savannah River and for the Clark Hill Reservoir studies on which hundreds of determinations were performed.

SPECIAL STUDIES

Special studies that were carried out to supplement routine data collections and analyses are listed below:

1. Several dissolved oxygen and salinity profiles on the lower Savannah River (mile 23 to mile 0) were made at various tidal stages and seasons.

2. Many dissolved oxygen, temperature, iron and manganese profiles (depth) were made in Clark Hill Reservoir starting on March 10, 1952.

3. Studies in estuarine waters relating to shellfish, fish and other biological organisms were performed. Some chemical determinations were performed as a supplement to the biological studies in these waters.

4. Rotenone was used for the collection of fish not obtainable by seining or trapping.

CHAPTER III

GENERAL DESCRIPTION

The Savannah River basin is predominantly a rural area, with about 20 per cent of the population residing in Augusta and Savannah. The principal uses of the basin water resources include the generation of hydroelectric power, shellfish production, and domestic and industrial water supplies. The Basin's watercourses receive domestic, raw and treated, sewage from 53 municipalities having a sewered population in excess of 240,000. It also receives industrial wastes from two pulp and paper plants which are estimated to have a population equivalent in excess of 200,000.

THE SAVANNAH RIVER BASIN

The drainage basin covers some 10,500 square miles of Georgia, South Carolina, and a small section of North Carolina.

The extreme headwaters of the Savannah River lie in the Blue Ridge Province of North Carolina, South Carolina, and Georgia, a heavily wooded mountainous area at altitudes as high as 5,000 feet. The Savannah River is formed by the confluence of the Tugaloo and Seneca Rivers near Hartwell, Georgia, and flows some 300 miles to discharge into the Atlantic Ocean near Savannah Beach, Georgia.

TOPOGRAPHY AND GEOLOGY (Clark Hill Dam to Atlantic Ocean)

From the foot of Clark Hill Dam to Augusta, a distance of some 18 miles, the Savannah River drops about 70 feet in elevation over a rocky bed. Its course is obstructed by two dams, Stephen's Creek Dam (29 feet in height) and the Augusta City Dam (10 feet in height). Because of the steep

gradient of the river in this stretch the backwaters of neither of these dams is very extensive. The backwater at the Stephen's Creek Dam has been so extensively silted in that a short distance above the dam it is only a few feet deep. Below Augusta at mile S-202.95, the New Savannah Bluff Lock and Dam creates a backwater which extends to mile S-219, just above Augusta. Here the last, naturally occurring, igneous rock is exposed in a series of rapids. From the foot of the New Savannah Bluff Dam to the region of marked tidal influence, at about mile S-30, the character of the river changes but little. The Sparganium marsh which is characteristic of the seacoast extends up the river to Big Collis Creek at mile S-29.83 where it ends abruptly. This may indicate the limit of regular tidal influence. However, a relatively wide range of tidal fluctuations at the Savannah River entrance sometimes causes noticeable semi-diurnal variations of water level to occur as much as fifty miles up the channel from the sea. The extent of the tidal influence depends upon the relative magnitude of the tide and the river flow. There are no tributaries entering the river in the Coastal Plain whose average flow is greater than 700 cfs. Over this 200-mile stretch the river follows a generally tortuous, meandering channel through a densely wooded 3 to 5 miles wide flood plain. The river bottom is composed largely of shifting sand; however, there are a number of places where the river swings to the edge of its flood plain and encounters the sedimentary formations of the Coastal Plain. At these points a variety of types of bottom materials are encountered, including clay, marl, gravel, sandstone and limestone. At meanders, where the river is cutting away at its own flood plain, the usual caving, vertical or undercut, clay bank

occurs on the outer edge of the meander. Banks may drop precipitously below the normal water level to the deepest part of the channel (often 10 to 12 feet at low water). From this maximum depth the river bed rises gradually to the water level on the inner side of meanders. The familiar pattern of erosion of the outer bank and silt deposition on the inner one is everywhere present. The successional nature of the sand bars is evident and they can be observed in all stages of deposition, overgrowth by willow, and conversion into the river swamp.

POPULATION

The Savannah River basin is predominantly a rural area having a 1940 population of 939,353, which represents an average density of 52 persons per square mile. About seventeen per cent of the total population (1940) reside in Augusta and Savannah, the basin's major cities. According to the 1950 census population figures for Savannah and Augusta are 119,689 and 71,507, respectively.

LAND USE

Agriculture is currently the chief economic activity of the basin. The farms of the region produce a large variety of products which include cotton, corn, tobacco, sugar cane, peanuts, vegetables, fruit, livestock, and poultry. Manufacturing activities are confined chiefly to the production of textiles, textile materials, paper, paper products, clay products and naval stores.

WATER USE AND DEVELOPMENT

Fish and Wildlife

Extensive areas of the lower Savannah drainage basin are utilized

for feeding, nesting and breeding areas by migratory wildfowl. The Savannah Bird Refuge is located on the delta lands in the lower river above Savannah, and the Tybee National Wildlife Refuge is located on the delta below Savannah.

The main stem of the Savannah River and its network of tributaries maintains both commercial and recreational fishing. However, the most important fisheries resource is the basin's shellfish industry. The waters of the minor delta channels in the vicinity of the mouth of the Savannah River are utilized as a nursery ground for young shrimp.

Recreation

Because of the climate and the natural and developed recreational areas, the region above Augusta is attractive to tourists and vacationists. Two of the principal storage reservoirs of the Tallulah River power system have been developed as recreational areas. The Savannah River between Augusta and Savannah has some recreational value. Below the city of Savannah the beaches on Tybee Island provide attractive sea bathing facilities.

Reservoirs and Diversion Projects

Clark Hill

The Clark Hill Project, a multi-purpose reservoir, has recently been completed except for the power house which is now under construction. Thetop five feet of the reservoir, elevation 330 to 335, will be used as storage for flood control. Below elevation 330 the reservoir will be used primarily to regulate flow for power generation. It is estimated by the Corps of Engineers that $104,000 annual flood damage in the valley below

the dam will be averted. Once in operation at power pool level, a minimum of 5,300 cfs regulated flow at Butler Creek gaging station below Augusta will be discharged. It is expected that the year-round natural channel depth between Augusta and Savannah will be increased to 7.3 feet by regulated flow.

Clark Hill Reservoir at top flood control pool (335 feet) will cover an area of 78,000 acres and will extend from the dam to about 37 miles up the Savannah River, with arms extending 29 miles up Little River, Georgia, and 17 miles up Little River, South Carolina. The shore line will be about 1,200 miles long and the reservoir will contain 2,900,000 acre-feet.

The average head for power will be about 130 feet with a minimum of 111 feet to a maximum of 151 feet. The ultimate power capacity of Clark Hill Dam will be 280,000 kilowatts.

Proposed Dams and Reservoirs

In addition to Clark Hill Dam and other existing works on the Savannah River and its tributaries, the Corps of Engineers has selected 10 future dam sites. None of these sites are downstream from Augusta. Hartwell Dam is authorized but no construction funds have been appropriated. Its site is on the Savannah River about eight miles below the junction of the Seneca and Tugaloo Rivers. Other selected sites are as follows: Newry-Old Pickens Site on Little River; War Woman, Sand Bottom, Rogues Ford and Camp Creek Sites on the Tugaloo River; Middleton Shoals and Goat Island Sites on the Savannah River between the Tugaloo and Broad Rivers; Tallow Hill and Anthony Shoals Sites on the Broad River.

Diversion of Savannah River Water

The city of Augusta Diversion Dam on the Savannah River is located a short distance downstream from the Stevens Creek Dam. The flow of Savannah River water to the Augusta Power Canal is regulated to the canal by gates at the head of the canal. The city of Augusta uses the canal as its source of water supply. Large textile mills use the canal as a source of hydroelectric power. Water used for such power generation is returned to the Savannah River via Sibley Mill gates, King Mill gates and Hawks Gully gates. The remaining water in the canal flows into Beaver Dam Ditch which carries most of Augusta's sewage and passes through Phinizy Swamp to join Butler Creek about 300 yards upstream from the confluence of Butler Creek with the Savannah River.

Navigation

The New Savannah Bluff Lock and Dam was completed April 1, 1937. It controls the depth of the Savannah River for 12 miles below Augusta. During the year 1949 the depth of the Savannah River was maintained at 4.0 feet or more for 95% of the time.

The operation of Clark Hill Reservoir should provide a year around depth of 7.2 feet in the Savannah River channel below Augusta.

Congress has authorized, but has not appropriated, funds for a 9 foot channel 90 feet wide from Augusta to Savannah Harbor. It is possible to establish a channel depth of 12 feet through the construction of two lock and dam systems below Augusta.

Water Supplies

Augusta, Georgia, uses Savannah River water as its total water

source while Savannah, Georgia, depends only partly on Savannah River water, with deep wells supplying most of its domestic needs.

Savannah's filtration plant, located near Port Wentworth, receives surface water from an intake on Abercorn Creek (Figure 2). The water in Abercorn Creek is largely Savannah River water with some swamp drainage. Most of the water from this plant is used for industrial purposes, though some 8 MGD is used for domestic purposes. For the first eight months of 1952 the water treated daily in this plant averaged 19.79 MGD.

Savannah obtains about 14 MGD of water from deep wells. There are indications that the artesian supply for the city of Savannah is being depleted. */ The charging area for these wells is in the area around Augusta.

Augusta is the only other city in the Savannah River Basin that uses Savannah River water. Its water supply intake is located in the Augusta Power Canal. Augusta's water filtration plant has seven 3 MGD filters. The maximum raw water pumping capacity is 19.75 MGD.

The other cities and towns in the basin use tributary streams or ground water as their source of water supply.

Sources of Pollution

Domestic Sewage

The estimated population connected to sewers in the Savannah River Basin is 306,000. Of this amount 150,000, or nearly half is accounted for by the two largest cities in the basin, Savannah and Augusta. Aiken,

*/ U. S. Geol. Survey Water-Supply Paper 987, p. 135, 1945.

South Carolina, discharges treated (secondary) wastes to Horse Creek and thence to the Savannah River. The pollution load to the Savannah River of these treated wastes is negligible.

North Augusta, South Carolina, discharges its raw sewage to the Savannah River at about mile S-216. Its present sewered population amounts to only 3,500, which is small compared to the dilution afforded by the river. However, when present sewer estimations are completed by July 1, 1954, its sewered population will be 12,000.

The pollution load from Augusta enters the Savannah River at two different points. The sewage from about 15% of the population, which amounts roughly to 10,000 P.E. (BOD), is discharged to the river near mile S-215. The remainder is discharged to Beaver Dam Ditch which flows through Phinizy Swamp and enters Butler Creek about 300 yards from the junction of Butler Creek with the Savannah River. Phinizy Swamp acts as a treatment plant to the Augusta sewage. It is estimated that at least 40 per cent of the raw sewage is oxidized and the pollution load to the Savannah River at mile S-202.65 is about 37,000 P.E. (BOD).

About 30,000 of Savannah's population (1950 census) of 119,689 receive secondary treatment. The treated sewage effluent is not discharged to the Savannah River, but to the Vernon River in the Intra-Coastal Waterway. The sewage from the remainder of the population is discharged raw to the Savannah River. It is estimated that the population equivalent of the domestic wastes from Savannah and of the industrial wastes from plants above Savannah that are discharged to the Savannah River is at least 300,000.

Industrial Wastes

Estimates in population equivalent figures of the amount of industrial pollution to the Savannah River are not available so no figure is included for this type of pollution. Some textile mills and finishing plants discharge wastes to tributaries of the Savannah River but their pollution effect on the river is negligible. For example, though the dissolved oxygen in Horse Creek (S.C.) which joins the Savannah River at mile S-213.4, is depleted by textile wastes during warm weather, its effect on the Savannah River is small because of the low flow in Horse Creek. There are no important industrial waste sources in Augusta, Georgia. At Savannah the two main sources of industrial pollution to the Savannah River are the Union Bag and Paper Company and the Southern Paperboard Corporation.

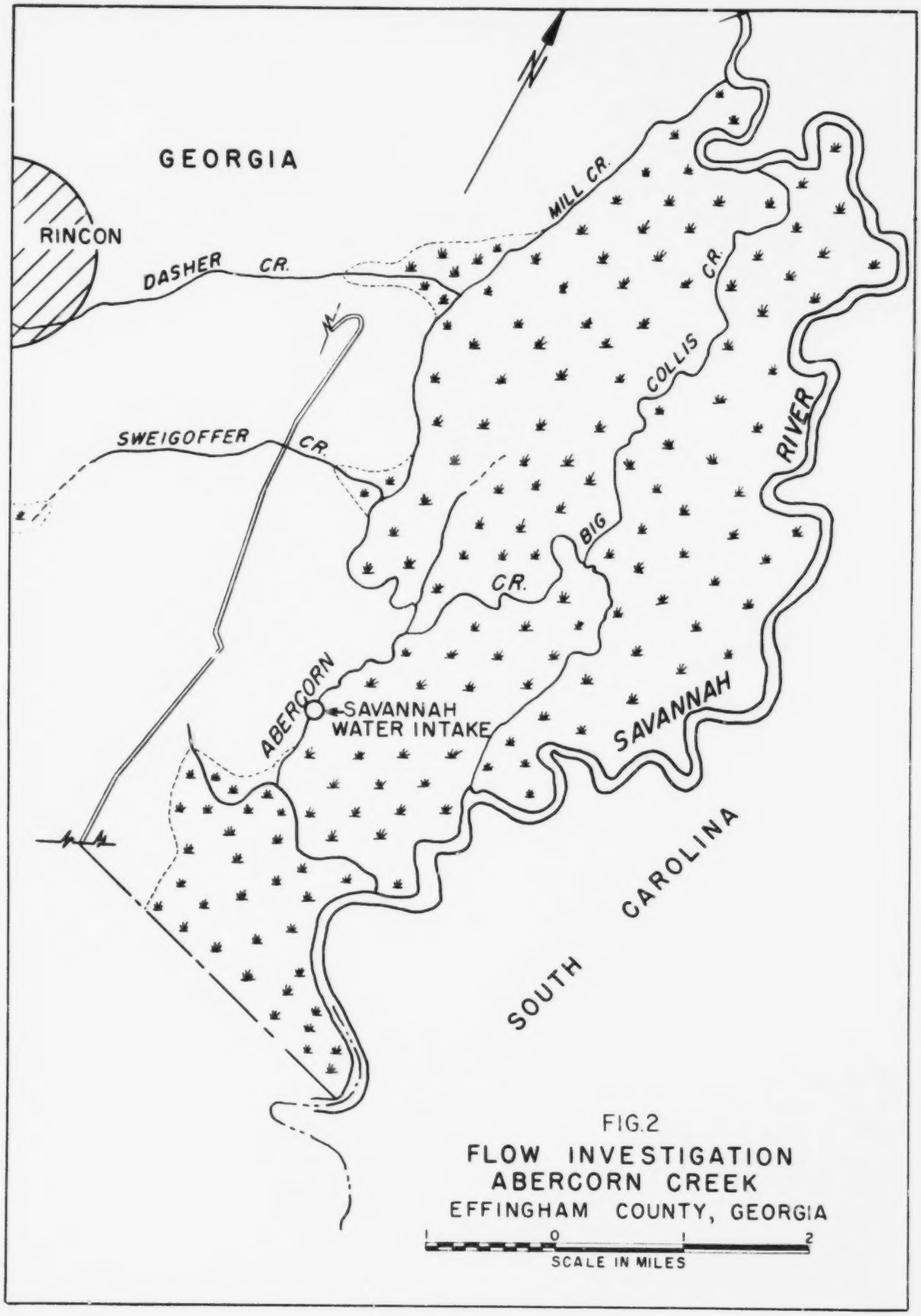


FIG.2
FLOW INVESTIGATION
ABERCORN CREEK
EFFINGHAM COUNTY, GEORGIA

CHAPTER IV

STREAM FLOWS

Information on stream flows and characteristics are available from many sources. Data used in this report were obtained principally from the U. S. Geological Survey.

DISCHARGE DATA

Savannah River at Augusta, Georgia

From U.S.G.S. data the average discharge at Augusta, Georgia, for the years 1898-1906, 1927-1931, 1938-48 is 10,860 second-feet. The drainage area at Augusta, including that of Butler Creek, is 7,508 square miles. The maximum discharge of official record was 350,000 second-feet on October 3, 1929. The maximum gage height was 46.3 feet September 27, 1929 at the auxiliary gage on Fifth Street Bridge on U. S. Highway 1 at Augusta. The minimum daily discharge was 1,040 second-feet on October 2, 1927.

The monthly average daily discharges at Augusta from July 1, 1951 to June 30, 1952 are presented in Table 1 and the average maximum and minimum daily discharges for that period are shown in Table 2.

Savannah River at Burtons Ferry Bridge

The U.S.G.S. records available at this gaging station cover the period October 1939 to September 1948. The maximum discharge during this period occurred on August 18, 1940 and amounted to 141,000 second-feet (gage height, 27.0 feet). A minimum daily flow of 2,240 second-feet occurred on October 18, 25, 1941. The average discharge for the water

year, 1947-48, was 15,000 second-feet. The drainage area is 8,650 square miles.

The monthly daily average discharges at Burtons Ferry Bridge on July 1, 1951 through June 30, 1952 are presented in Table 1. The average, maximum and minimum daily discharges during that period are shown in Table 2.

Savannah River Near Clyo

The U.S.G.S. gage is located on the Seaboard Air Line Railroad bridge at S-65. The drainage area amounts to 9,850 square miles.

For an 11 year period (October 1937-September 1948) the average discharge was 11,530 second-feet. During the same period the maximum discharge of 128,000 second-feet occurred on August 21, 22, 1940. The minimum daily discharge of 2,830 second-feet occurred October 19, 25-28, 1941.

The monthly average daily discharges at S-65 (near Clyo) from July 1, 1951 through June 30, 1952 are presented in Table 1. The average maximum and minimum daily discharges for that period are shown in Table 2.

Augusta Canal near Augusta, Georgia

The average discharge (U.S.G.S. data) for 17 years (1931-48) was 2,636 second-feet. The maximum daily discharge occurred on January 2, 28, 1948 and was 4,380 second-feet. There was no flow in the canal from April 8 to May 10, 1936.

Brier Creek at Millhaven, Georgia

The drainage area is 656 square miles. For an 11 year period (April 1937-September 1948) the average discharge for that period was 673

second-feet. A maximum discharge of 25,400 second-feet occurred on August 16, 1940. A minimum discharge of 110 second-feet was recorded on June 30, July 2, 1945.

TABLE 1 - DAILY AVERAGE SAVANNAH RIVER DISCHARGE,
IN CFS, FOR THE PERIOD
JULY 1, 1951 TO JUNE 30, 1952
BASED ON PROVISIONAL DATA FROM THE U.S.G.S.

Month	Augusta (S-202.65)	Burtons Ferry Bridge (S-129.25)	Near Clyo (S-65)
July 1951	4,570	5,230	5,740
August	3,470	4,150	4,790
September	3,390	3,860	4,210
October	2,730	3,600	4,210
November	4,200	5,100	5,870
December	8,660	8,630	8,740
January 1952	8,650	9,920	11,590
February	5,840	7,310	8,910
March	29,090	28,640	27,930
April	21,810	26,650	31,150
May	6,780	8,170	10,040
June 1952	4,340	4,680	5,680

TABLE 2 - AVERAGE, MAXIMUM AND MINIMUM DAILY DISCHARGES
IN CFS, FOR THE PERIOD
JULY 1, 1951 TO JUNE 30, 1952

	Augusta (S-202.65)	Burtons Ferry Bridge (S-129.25)	Near Clyo (S-65)
Average	8,640	9,670	10,740
Maximum	38,600	37,100	41,300
Minimum	1,710	2,120	2,860

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CHAPTER V

CHEMICAL, BACTERIOLOGICAL AND PHYSICAL STUDIES

The routine laboratory tests included dissolved oxygen, biochemical oxygen demand, oxygen consumed, pH, turbidity, alkalinity, color and chloride. The routine bacteriological test performed was the coliform MPN (most probable number) per 100 ml. The above data are tabulated in Appendix "A."

The mineral analysis of Savannah River water samples include the following determinations: suspended solids (total and ash), silica, sulfate, magnesium, sodium and potassium, total dissolved solids, iron, fluoride, nitrate, manganese, orthophosphate, total phosphate, calcium, bicarbonate, chloride, iron and aluminum oxides, and aluminum.

Chemical and bacteriological and physical determinations were for the most part performed in accordance with Standard Methods for the Examination of Water and Sewage, Ninth Edition, 1946, of the American Public Health Association. Minor modifications of the standard procedures and new methods used were developed at the Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio. These were described in the "Interim Report on Savannah River Studies, July 1951 - March 1952." Iron and manganese determinations are presented in Appendix "F."

Especially pertinent chemical, bacteriological, and physical data are discussed below as such relate to water quality of the section of the Savannah River that was surveyed. Also, special studies that relate specifically to the objectives of this survey are included here.

WATER QUALITY

Dissolved Oxygen

In general, the mean data curve shows that the Savannah River from above Augusta, Georgia, to Savannah, Georgia, is good. Below Savannah the dissolved oxygen conditions deteriorate rapidly, as shown in Figure 3.

The minimum dissolved oxygen values indicate the most critical conditions encountered. Such conditions usually occur during warm summer months at times of low flows. Figure 3 shows that the Savannah River was in good condition from above Augusta to Savannah but just below Savannah at mile S-11 there were times when the Savannah River was completely depleted of oxygen. Such a depletion of oxygen causes what is sometimes termed an "oxygen block" in the river. If an "oxygen block" occurs when fish are migrating downstream to the ocean or from the ocean upstream, large numbers of fish may die in their efforts to continue their journey through the "oxygen block". Fish kills have been reported from the lower river in very recent years but their nature or extent could not be ascertained.

Biochemical Oxygen Demand

In general, the mean and maximum BOD values, as shown in Figure 4, are quite low. There is an increase in BOD below Savannah, as is to be expected below a point of pollution. It is of interest to note that Augusta and North Augusta do not appreciably increase the mean BOD values. The maximum values are slightly over 2 ppm and indicate there is some pollution but not enough to significantly deplete the oxygen resources.

Individual BOD values are presented in Appendix "A".

Coliform MPN

Coliform organisms in large numbers are indicative of fecal pollution. However, these may also be found in large numbers in surface runoff from cities and agricultural areas.

A summary of the median, maximum and minimum values for the coliform MPN per 100 ml. test data are presented as a bar diagram in Figure 5. Samples for the coliform test were usually taken at third or quarter points across the stream at each sample station. Upon summarization there was not a sufficient difference at points across the stream to warrant plotting on a stream width as well as stream length basis. Often there was an appreciable difference in the individual samples across the stream.

Usually the median coliform values, as shown in Figure 5, are in excess of 40,000 MPN per 100 ml. for 50 miles of river below Augusta.

The median coliform values of the Savannah River above Augusta are usually less than 1,000 MPN per 100 ml. The Savannah River above Augusta is a suitable source of surface water for Augusta, from the bacteriological standpoint.

Minerals

The Savannah River water is mostly in contact with relatively insoluble silicate minerals and is therefore soft and very low in mineral content except for the estuarine portion which is mixed with sea water.

The results from the mineral determinations are presented in tabular form in Appendix "B".

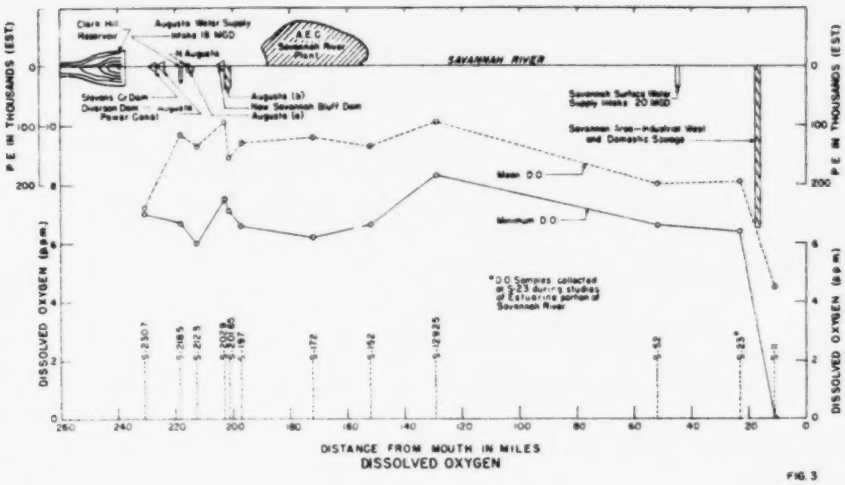
Excluding samples from Station S-11 which are partially sea water, only one analysis out of 23 on the main stem of the river showed a total dissolved solids content greater than 80 ppm. Analyses of tributary waters sometimes exceeded 120 ppm total dissolved solids.

Excluding samples from S-11, of 33 analyses the only mineral constituent exceeding 10 ppm was silica except one result for sulfate and one for chloride. Silica seldom exceeded 25 ppm and was generally less than 20 ppm. The Savannah River contained less than 0.2 ppm fluoride. The manganese content was seldom over 0.03 ppm and frequently less than 0.01 ppm before water was impounded in Clark Hill Reservoir. After water impoundment in Clark Hill Reservoir, a manganese content of 0.6 ppm was found in the river water just below Clark Hill Dam (Page 9 of Appendix "C").

The Savannah River and the tributaries through the Savannah River Project Plant area are low in nitrate and total phosphate. Nitrate values seldom exceed 2 ppm and were usually less than 1 ppm. The results for total phosphate were less than 0.7 ppm and few exceeded 0.5 ppm.

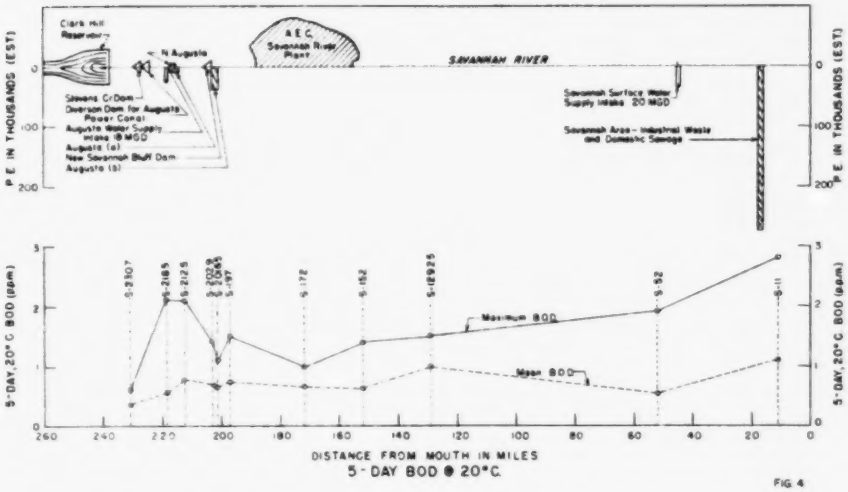
Excluding the samples from S-11, the results from magnesium determinations of main stem and tributary waters were less than 2 ppm. Results for calcium were less than 6 ppm in the main stem. Determinations on water samples from Steel Creek, South Carolina, showed slightly more calcium but not more than 9 ppm. The waters in Lower Three Runs, South Carolina, contained as much as 17 ppm calcium in one of two determinations. Sodium and potassium together were generally less than 10 ppm.

Bicarbonate is the principal acid radical in Savannah River water.



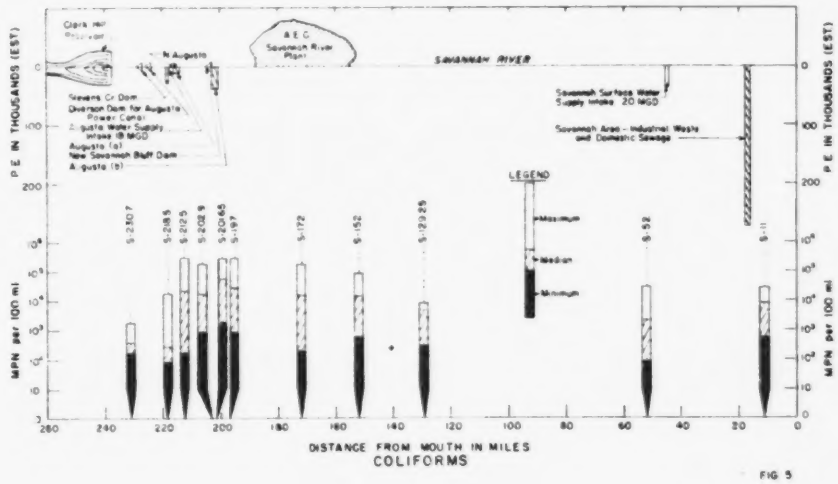
DISSOLVED OXYGEN

FIG. 3



5-DAY BOD @ 20°C.

FIG. 4



COLIFORMS

FIG. 5

The bicarbonate content of the Savannah River and tributary waters is variable. It ranged from 3.5 ppm to 22 ppm.

Turbidity

In summarizing the turbidity data at each sampling station on the Savannah River it was found that the mean value varied considerably from station to station. The minimum mean value was 62 ppm and the maximum mean value was 115. Single turbidity values ranged from a minimum of 8 ppm to a maximum of 440 ppm.

When one looks at the Savannah River from its shore, the river has a red muddy appearance and gives the illusion of high turbidity. This red muddy appearance of the stream is caused by colloidal red clay. The water on examination in the laboratory is not nearly as turbid as the stream appearance suggests since the colloid affects "apparent color" rather than turbidity.

Color

There are two types of "color" in water: "true color" defined as the color due to dissolved substances only, and "apparent color" defined as the color contributed by the suspended material as well as by substances in solution.

The color determinations performed in the Savannah River Studies laboratory were for "true color."

Mean values of color were calculated from data for each station. These mean values ranged from 18 to 132 ppm. Single values from all the stations ranged from 10 to 240 ppm. Most of the "true color" in the Savannah River water is caused by organic material from decomposed plant

residues, since large swampy areas border both sides of the stretch of the Savannah River between Augusta and the Atlantic Ocean. The absence of swamps above Augusta accounts for the lower color values in this reach of river.

The "apparent color" of the water is high because of the red clay colloid which is difficult to remove. The colloid could not be removed from the water by filtration through filter paper but it was removed satisfactorily by a centrifuge.

SPECIAL STUDIES

Dissolved Oxygen and Salinity Studies in the Savannah River Estuary

On March 28, 1952, when the estimated flow in the river at Savannah was 37,300 cfs, dissolved oxygen and salinity were determined at 2 mile intervals from mile 23 to mile 2 during high tide, between mean and high tide, during mean and low tide. Alkalinity was determined on samples taken at high and low tides. On bottom samples taken 3 feet from the bottom at high tide the critical point for the dissolved oxygen profile was at mile 5 as shown in Figure 7. The D.O. value at this point was 4.7 ppm. For a sample taken 3 feet from the surface at the same time, the curve was still descending at mile 2. The D.O. value at this point was 5 ppm. Samples for chloride and alkalinity were taken at the same time and at the same points as for dissolved oxygen. At high tide the surface samples (3 feet from surface) and bottom samples (3 feet from bottom) have alkalinity and salinity values that parallel from mile 23 to mile 8 as shown in Figure 8. The bottom samples increased very rapidly in alkalinity and salinity from mile 5 to mile 2, while the increase for the surface samples was small.

Between mean and high tide on March 28, 1952 the critical point of the oxygen sag curves for bottom and surface samples shown in Figure 9 were at mile 8 and mile 5, respectively. Compared with the oxygen sag curves at high tide, the critical points had moved upstream 3 miles.

As shown in Figure 10, the salinity in terms of per cent sea water increases rapidly from mile 11 downstream as determined from samples taken between mean and high tide.

During mean tide on March 28, 1952 the critical point of the oxygen sag curve for the bottom samples shown in Figure 11 was at mile 11. The dissolved oxygen value at this point was 3 ppm (estimated Savannah River flow 37,300 cfs.) The oxygen sag curve determined from surface samples was still descending at mile 2 so no critical point can be designated in the range, 8-23 to 8-2. The salinity of the bottom samples increased rapidly from mile 6 downstream, as shown in Figure 12, and amounted to 55 per cent sea water at mile 2. The salinity of the surface samples increased more gradually from mile 6 downstream and amounted to 9 per cent sea water at mile 2.

As shown in Figure 13, the dissolved oxygen values for both bottom and surface water decreased downstream from mile 20 at low tide. At mile 2 the dissolved oxygen values were 6.3 and 5.2 ppm for surface and bottom samples respectively.

Referring to Figure 14, alkalinity values for surface and bottom samples were approximately the same for the entire section. In terms of per cent sea water the salinity increase was moderate starting from less than 1 per cent at mile 8 and increasing to 15 per cent at mile 2 for

bottom samples (Figure 14.) At low tide on March 28, 1952 the salinity of surface samples increased from less than 1 per cent at mile 5 to about 2 per cent sea water at mile 2.

On June 23, 1952 when the estimated river flow was 5,400 cfs at Savannah another dissolved oxygen and salinity study was made covering the Savannah River section, S-23 to S-0.

During high tide the critical point of the oxygen sag curve for surface samples occurred at mile 17 as shown in Figure 15, while the critical point at low tide occurred at mile 3. The critical oxygen values at high and low tides for surface samples were 1.4 ppm and 2.8 ppm, respectively. For bottom samples, Figure 16, critical oxygen values of 1.0 ppm at high tide and 1.5 ppm at low tide occurred at mile 17 and 14, respectively. Comparison of the oxygen sag curves for surface and bottom samples at high tide, as shown by Figure 17, showed little difference between them. The oxygen sag curves for surface and bottom samples at low tide, Figure 18, showed similarity from mile 23 to 18 and from mile 8 to 0. There is quite a difference in the stretch, mile 18 to 8, with the critical value of the bottom sample amounting to 1.5 ppm at mile 14 while that for surface samples is 2.8 ppm at mile 3.

As shown in Figure 19 there is a marked difference in salinity between surface and bottom samples from mile 20 downstream. There is also a marked difference in salinity at low and high tides below mile 20. The data discussed above are tabulated in Appendix "D."

Study of Sludge Bank in Lower Savannah River Section, S-14 to S-8

During sampling operations in the Lower Savannah River section it

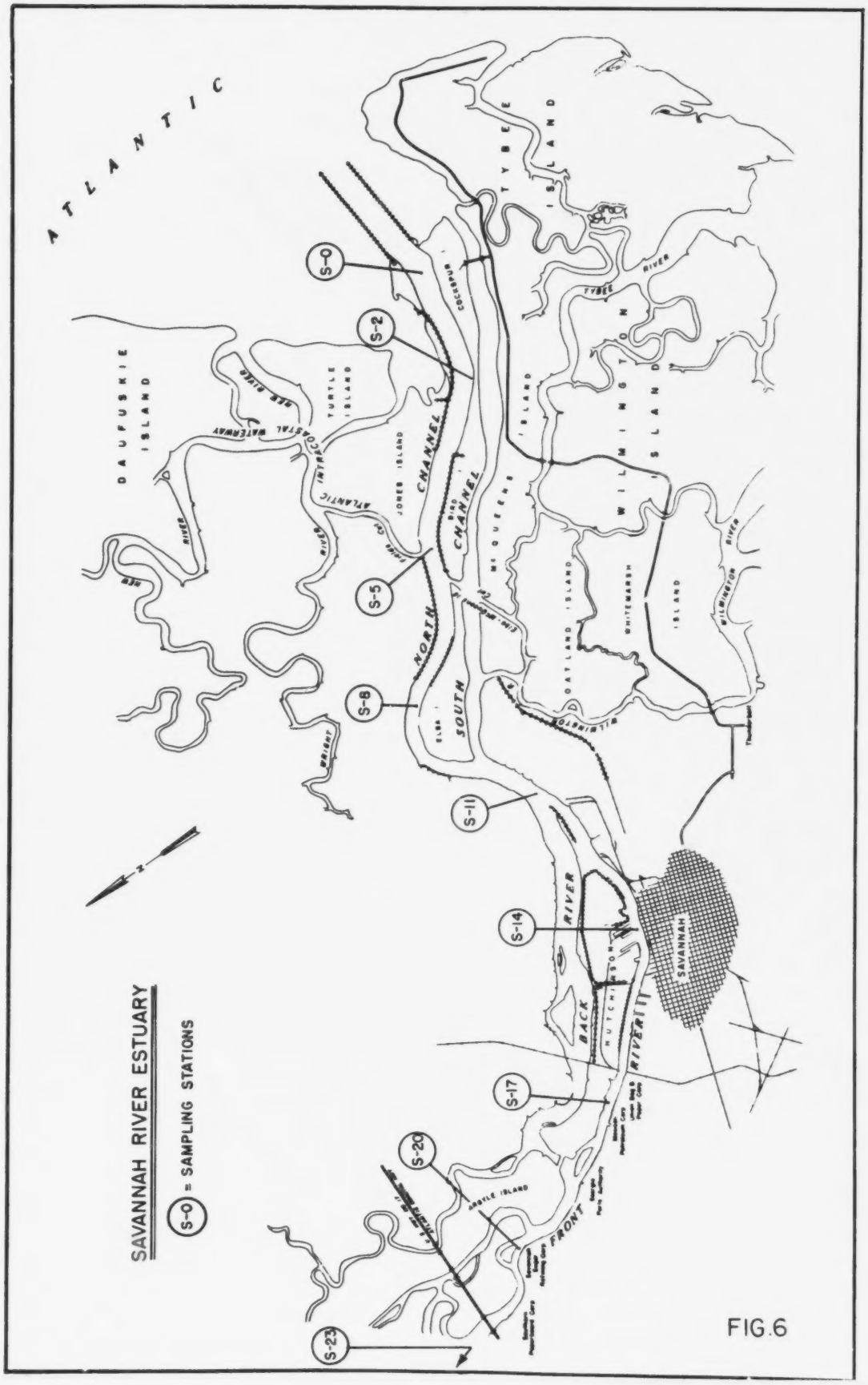
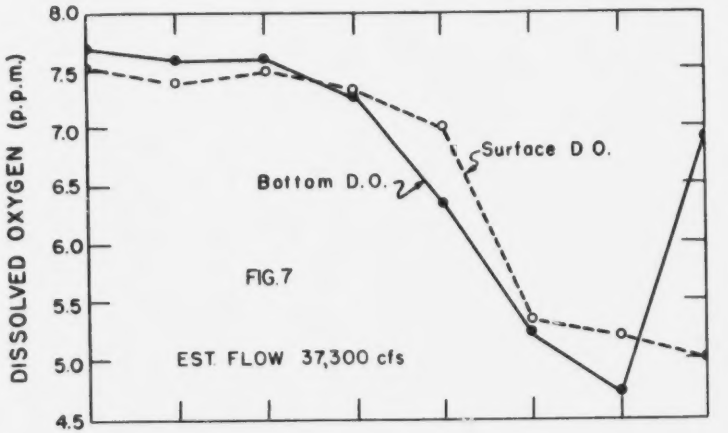
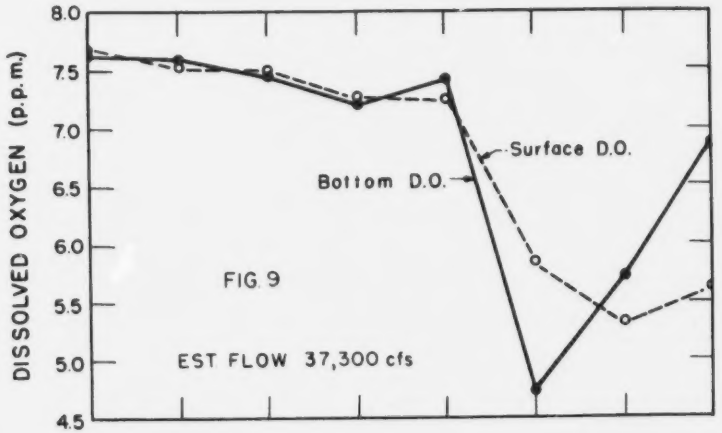
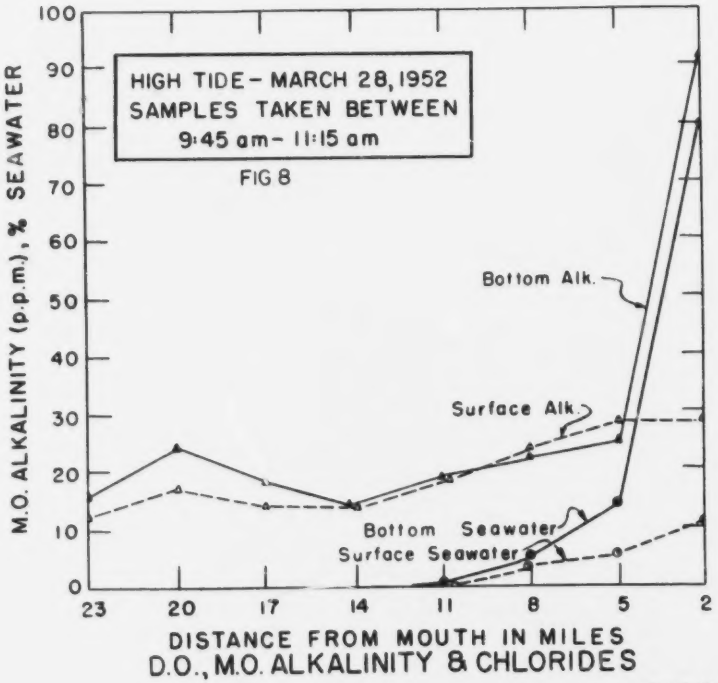

SAVANNAH RIVER ESTUARY
S-0 = SAMPLING STATIONS
ATLANTIC
DAUFUSKIE ISLAND
TURTLE ISLAND
JONES ISLAND
NORTH CHANNEL
SOUTH CHANNEL
TYBEE ISLAND
WILMINGTON ISLAND
OATLAND ISLAND
WHITEMARSH ISLAND
BACK RIVER
FRONT RIVER
SAVANNAH
HUTCHINSON
ARGYLE ISLAND
S-0
S-2
S-5
S-8
S-11
S-14
S-17
S-20
S-23

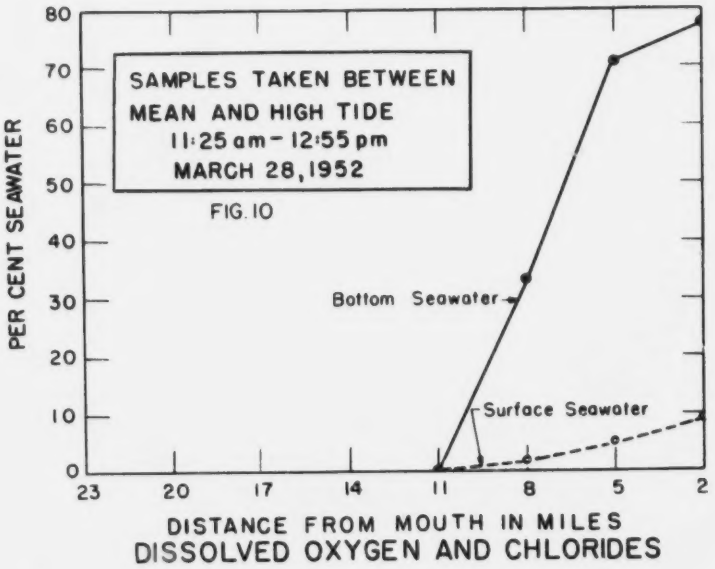
FIG.6



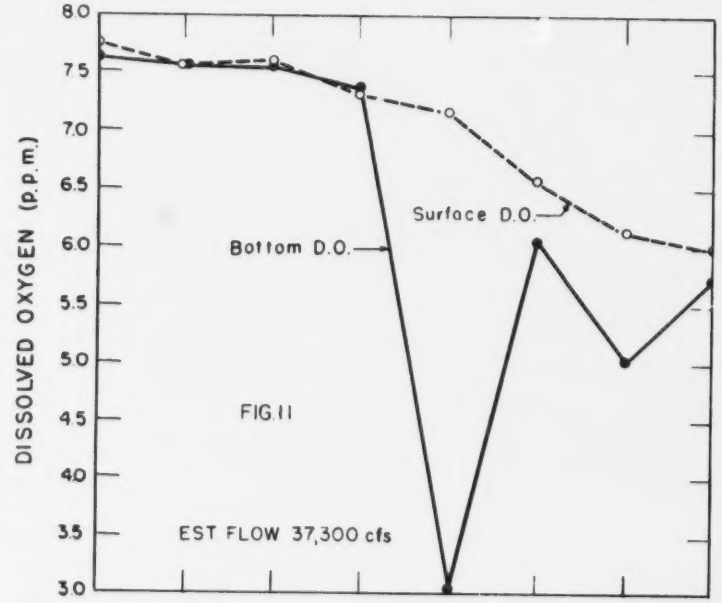


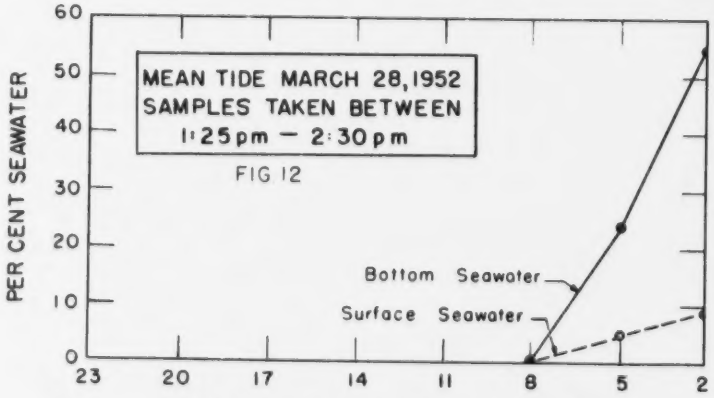


FIGS. 7 & 8



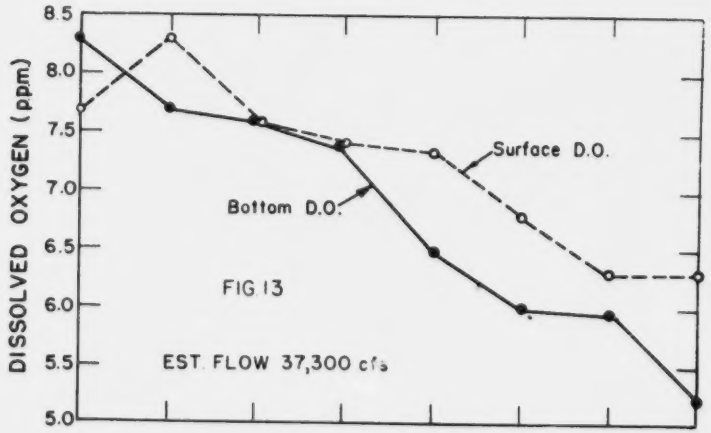
FIGS. 9 & 10

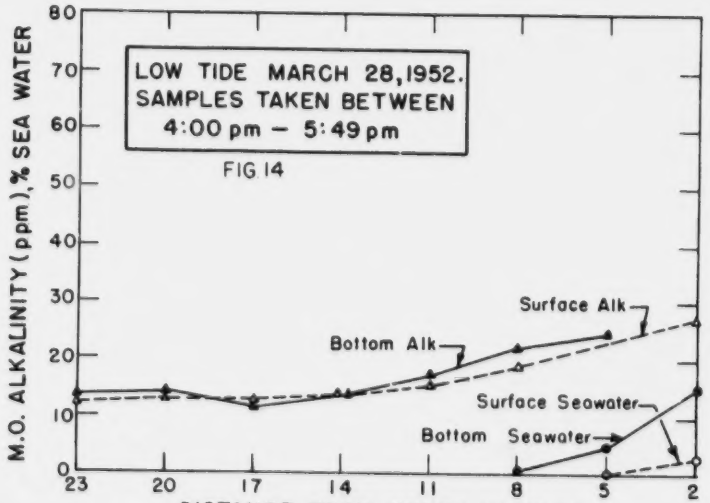




DISSOLVED OXYGEN AND CHLORIDES

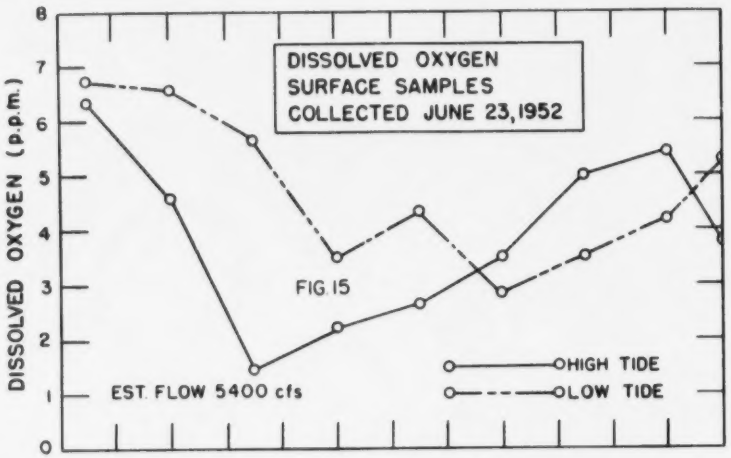
FIGS 11 & 12

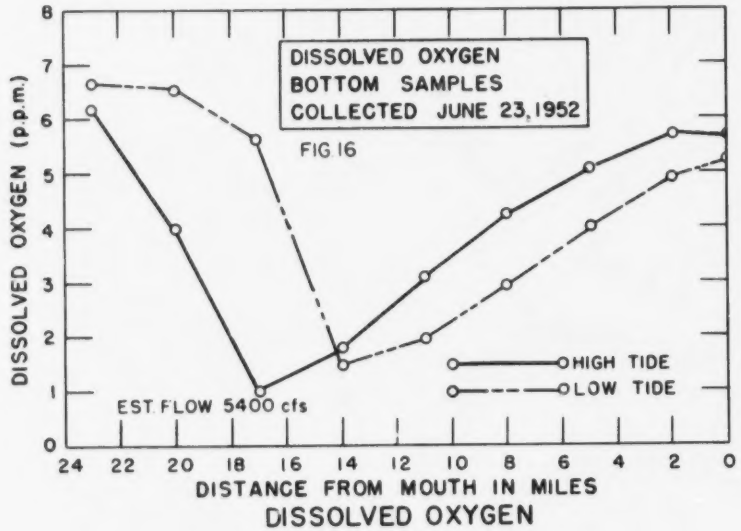




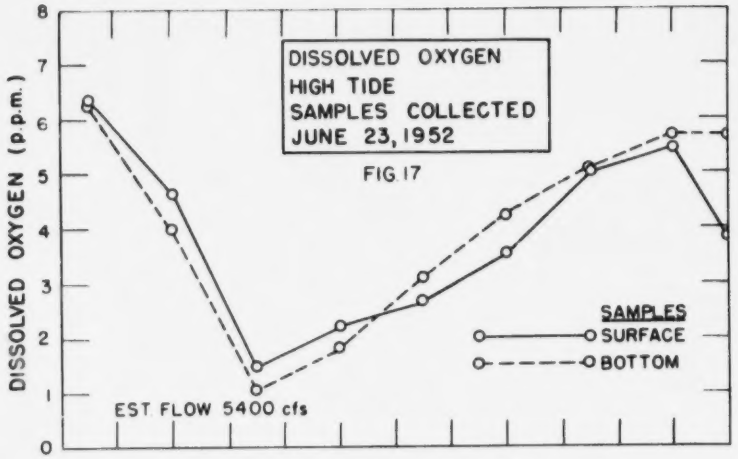
D.O., M.O. ALKALINITY & CHLORIDES

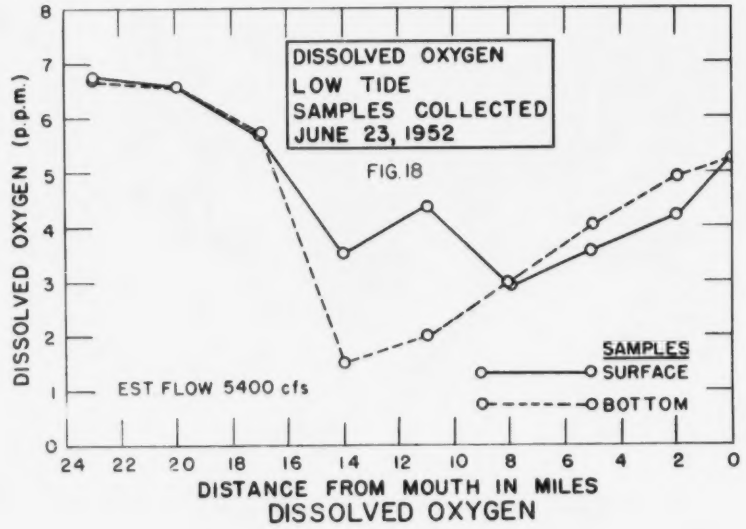
FIGS. 13 & 14





FIGS. 15 & 16





FIGS. 17 & 18

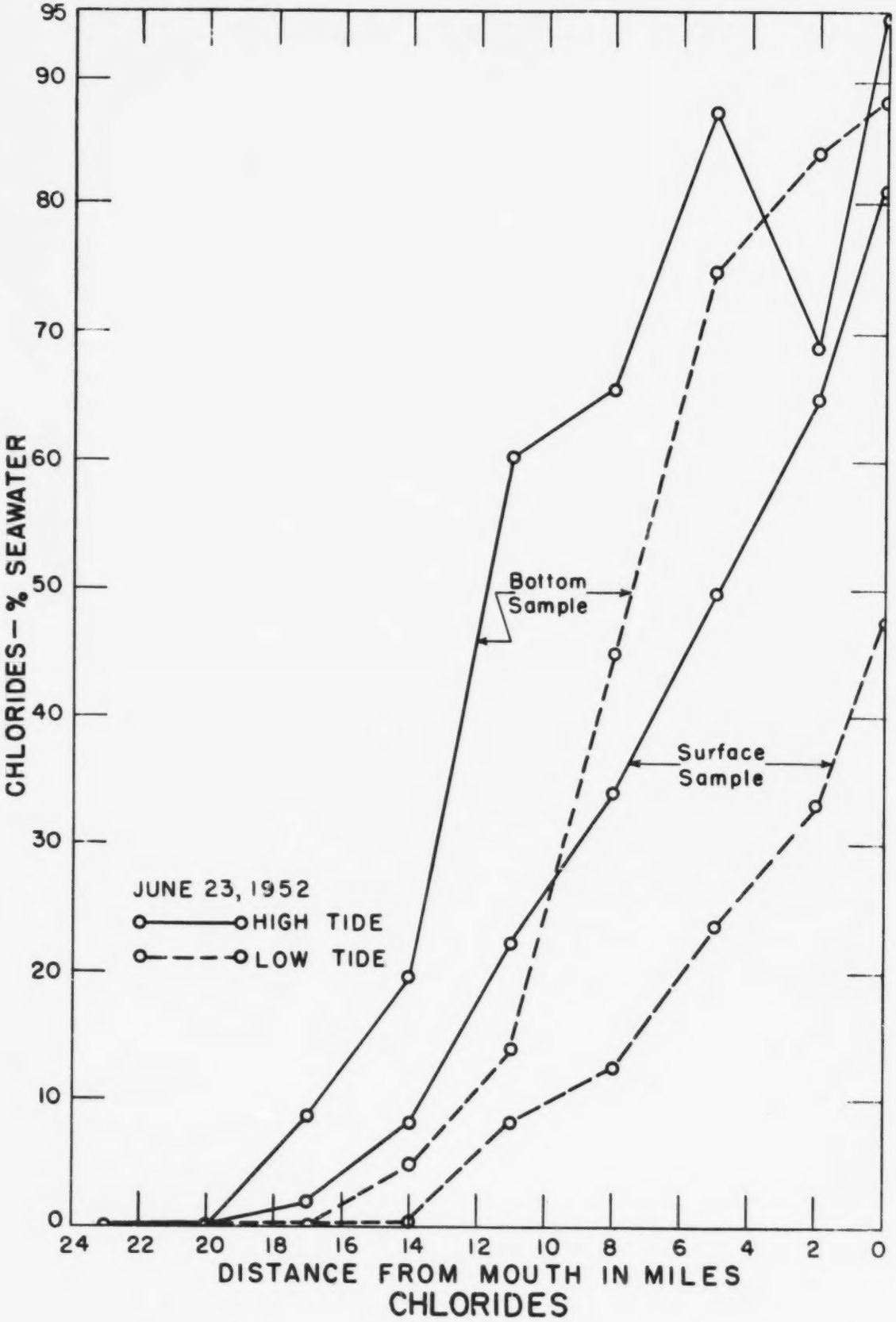

95
90
80
70
60
50
40
30
20
10
0
CHLORIDES — % SEAWATER
24
22
20
18
16
14
12
10
8
6
4
2
0
DISTANCE FROM MOUTH IN MILES
CHLORIDES
Bottom Sample
Surface Sample
JUNE 23, 1952
HIGH TIDE
LOW TIDE

FIG. 19

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was noticed that a sludge bank existed in the main channel. The sludge bank varied in depth from 6 to 11 feet from approximately mile 14 to mile 8 or mile 8 to mile 2 depending on the flow in the river and the time. The sludge bank actually extends upstream to mile 20 but it is usually less than 6 feet thick above mile 14.

The Corps of Engineers, Savannah District, obtained samples of the sludge at several depths in the sludge bank at mile 11 and mile 14.

The main purpose of the sludge study was to determine the amount of organic matter present at various sludge depths so that the effect on the dissolved oxygen in the stream could be appraised. The results of the chemical analyses are presented in Table 3.

TABLE 3 - CHEMICAL ANALYSES OF SLUDGE SAMPLES FROM S-11 AND S-14

Sample Station	S-11	S-11	S-11	S-14	S-14
Depth from Surface of Sav.River	33'	36'	37'	32'	35'
Lab. No.	573	574	575	576	577
Specific Gravity	1.007	1.087	1.106	1.042	1.081
% Solids	2.044	13.79	17.91	7.557	13.05
Total Susp Solids - ppm[a]	16,450	120,000	137,000	56,530	96,240
Total Susp.Ash-ppm[a]	13,810	102,370	116,510	47,980	55,010
Total Susp. Volatile-ppm[a]	2,640	17,630	20,490	8,550	43,200
TSS- Dry Basis %	80.48	87.02	76.49	74.80	75.28
TSA- Dry Basis %	67.56	74.23	65.05	63.49	42.18
TSV- Dry Basis %	12.92	12.78	11.44	11.31	33.10
Chlorides ppm Cl[a]	2,330	5,060	4,900	4,800	6,120
Chlorides Dry Basis %	13.64	3.67	2.74	6.35	4.69
Oxygen Consumed ppm[a]	1,810	11,600	15,500	6,520	11,200
Oxygen Consumed Dry Basis %	8.85	8.38	9.20	8.62	8.57

a/ Values corrected for specific gravi

From the results presented in Table 3 it can be seen that the oxygen consumed values on sludge samples increased greatly the deeper the sample was in the sludge bank, however, on a dry basis there was little difference with increase in depth. The reason for this is obvious. The sludge at increasing depths decreases in water content. On a dry basis the volatile matter in the sludge at mile 11 amounted to about 12 per cent for all three depths while at mile 14 an increase of 3 feet in depth in the sludge bank increased the volatile solids content from a value of 11 per cent to one of 33 per cent.

The results of the chemical analysis of the sludge samples indicate that the sludge bank at mile 14 and mile 11 is probably a mixture of Savannah River silt, solids from city of Savannah raw sewage and fiber from pulp and paper industries upstream.

Clark Hill Reservoir Studies

The studies relating to Clark Hill Reservoir were originally intended only to determine the build-up of soluble iron and manganese in the lower depths of the reservoir. However, it was decided to determine the temperature and dissolved oxygen profiles, because of their biological significance and as indicators of currents and stratification in the reservoir; and turbidity because of the information it could give regarding the settling characteristic of the suspended load entering the reservoir.

Shortly after January 20, 1952 the pool elevation of Clark Hill Reservoir passed the 270 ft. level and on March 5, 1952 the pool elevation was about 300 ft. Sampling activities were initiated on March 10, 1952. A map of Clark Hill Reservoir at full pool level on which the

sampling locations are located by arrows is shown in Figure 20. A summary of individual analytical results for Clark Hill Reservoir appears in Appendix "C."

Water samples taken on March 10, 1952 at a point one mile above Clark Hill Dam where the total water depth was 98 ft. showed increasing manganese content as the sample depth increased. The values of soluble manganese content at depths of 23 ft. and 73 ft. were 0.002 and 0.012 ppm, respectively, and the soluble iron content was 0.54 and 0.55 ppm, respectively. On May 6, 1952, at the same distance above the dam and where the total water depth was 114 ft., values for manganese content at depths of 64 ft. and 111 ft. were 0.0013 and 0.27 ppm, respectively. The iron content of these same samples taken at 64 ft. and 111 ft. depths was 0.048 and 0.68 ppm, respectively.

Other samples taken at the previously cited station and at other points in the reservoir, as well as below the dam, confirm the conclusion that the build-up in soluble iron and manganese near the bottom is rapid.

A water sample taken from the Savannah River about 1/4 mile downstream from Clark Hill Dam on May 26, 1952 contained 0.60 ppm of manganese and 0.04 ppm of iron. The temperature of the water sample was 27°C, the dissolved oxygen content was 9.2 ppm and turbidity was 8 ppm. Since the solubility of oxygen in water at a temperature of 27°C is 8.1 ppm, the water sample was supersaturated with oxygen. The aeration of the water as it passes over the spillways of the dam will oxidize some of the soluble iron and manganese converting them to insoluble compounds. Such aeration action is desirable.

Water samples were taken at several depths from Clark Hill Reservoir at a point one mile above Clark Hill Dam (S-239.1). The total water depth at this point was 115 feet. Analytical data on the water samples taken at this station are presented in Table 4.

TABLE 4 - ANALYTICAL DATA ON SAMPLES TAKEN MAY 26, 1952 FROM S-239.1

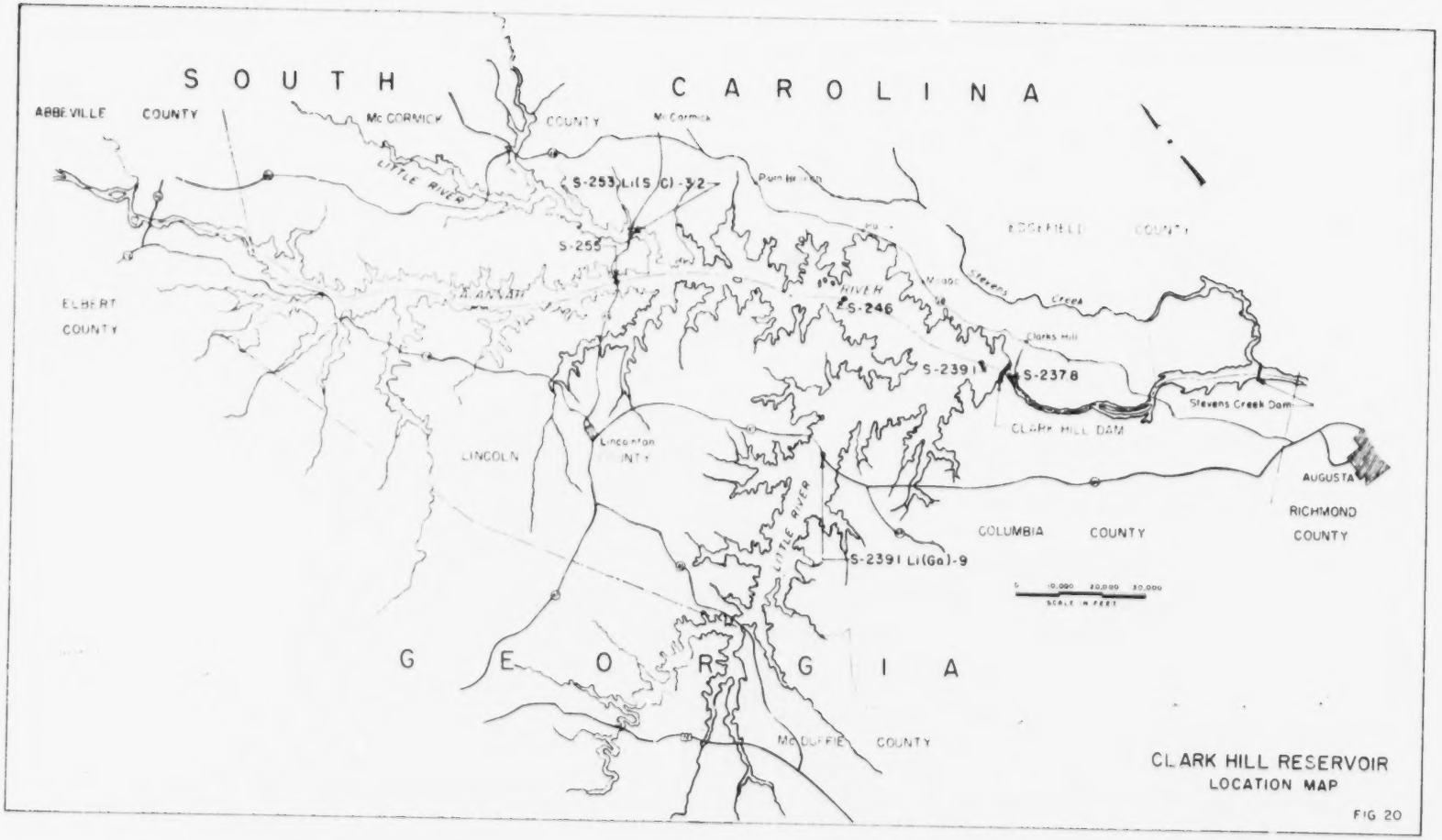
Clark Hill Reservoir

Depth ft.	Temp. °C.	Manganese ppm	Iron ppm	Diss. Oxygen ppm	Turbidity ppm
3	25	-	-	7.7	1
13	24	-	-	7.4	1
38	22	-	-	4.9	2
63	21	0.033	0.08	4.0	4
88	20	0.24	0.032	2.0	4
113	19	1.12	0.12	0	15

The determinations of iron and manganese were performed on clarified samples. Out of curiosity, determinations were performed on non-clarified water samples. While there was no change in the manganese value, the value for iron was considerably greater (over 1.0 ppm) in the non-clarified sample.

The relationship of dissolved oxygen to depth covering a four month period at Stations S-239.1 is shown in Figures 21, 22, 23, and 24. Stratification is quite obvious beginning on May 1 through July 28 with the exception of May 21.

Turbidity values of samples taken at Station S-239.1, one mile above Clark Hill Dam, on March 31 and May 6, 1952, are shown for comparison in Table 5.



CLARK HILL RESERVOIR
LOCATION MAP

FIG 20

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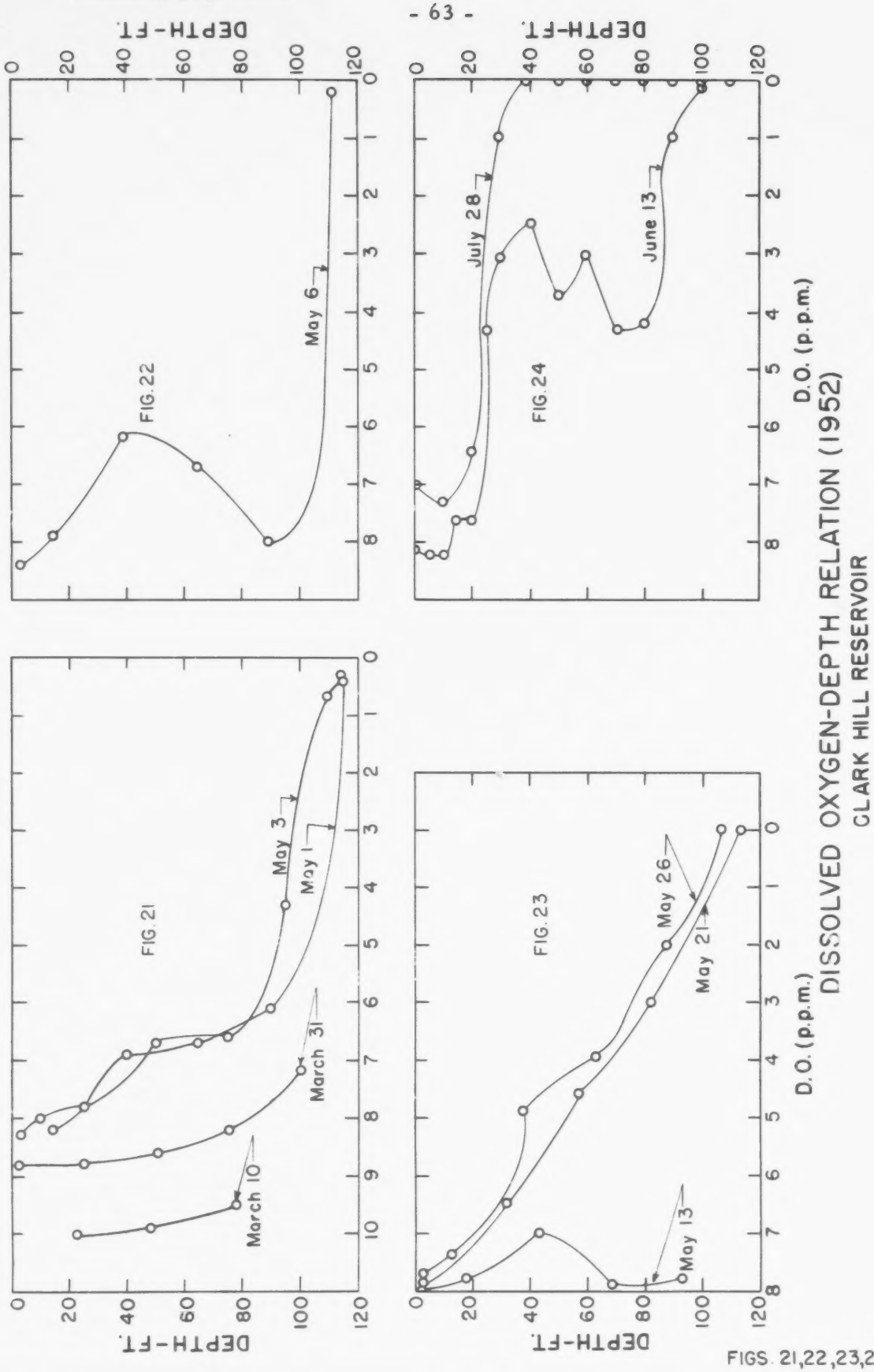

DISSOLVED OXYGEN-DEPTH RELATION (1952)
CLARK HILL RESERVOIR

FIGS. 21,22,23,24

SAVANNAH RIVER STUDIES
JAN. 22, 1951 TO JAN. 21, 1952

FIG. 25

COMPARISON OF AIR & WATER TEMPERATURES
AUGUSTA CANAL
FEBRUARY 4, 1951 TO FEBRUARY 3, 1952

FIG 26

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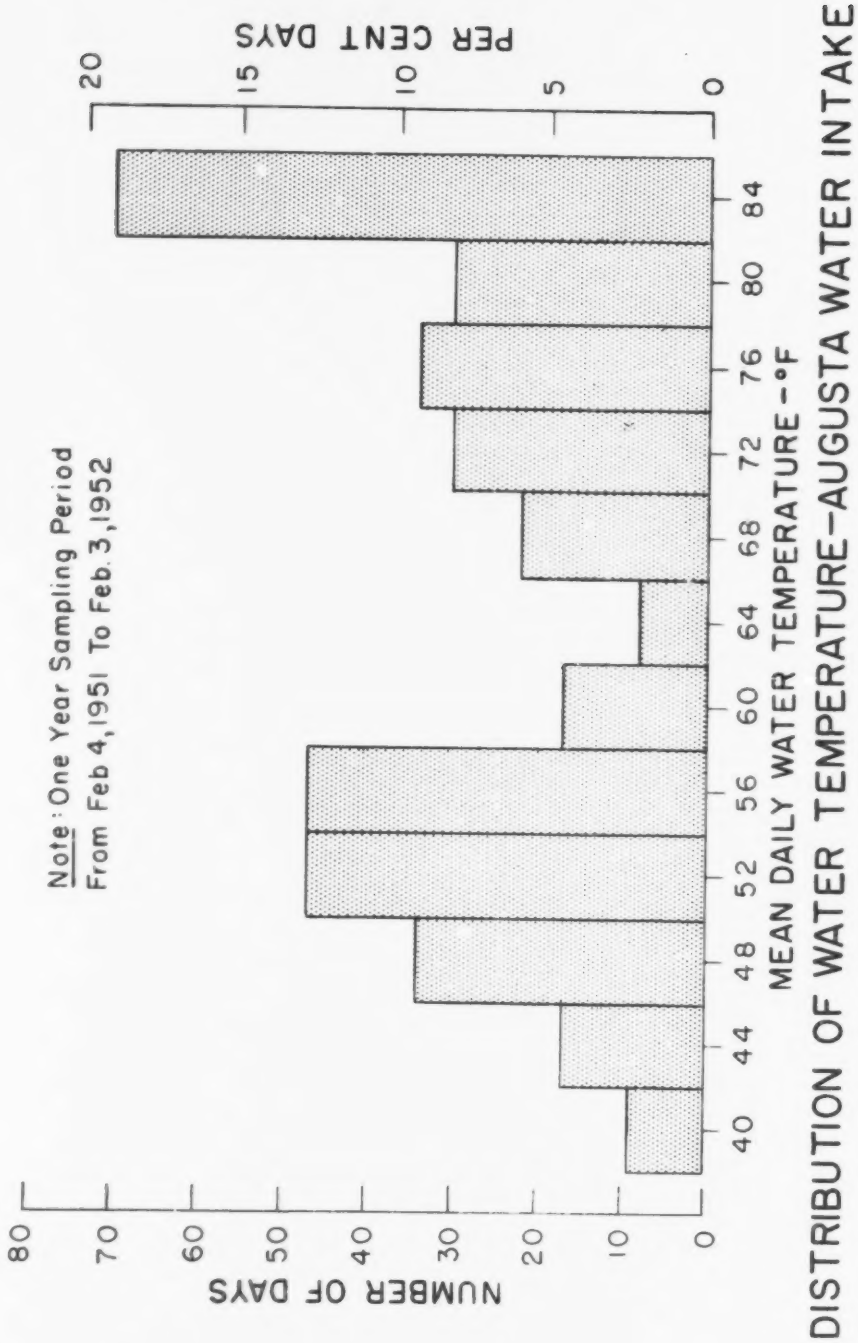

DISTRIBUTION OF WATER TEMPERATURE–AUGUSTA WATER INTAKE

FIG. 27

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TABLE 5 - TURBIDITY VALUES ON SAMPLES TAKEN AT S-239.1 ON MARCH 31 AND MAY 6, 1952

March 31, 1952		May 6, 1952	
Depth Ft.	Turbidity ppm	Depth Ft.	Turbidity ppm
Sur	140	3	1
25	155	14	2
50	185	39	3
75	175	54	8
100	98	89	4
130 (Total Depth)	-	114 (Total Depth)	-

Table 5 shows that in 5 weeks time the suspended load has almost settled completely.

On June 13, 1952 temperature determinations were made at various depths in Clark Hill Reservoir at S-239.1 with an electrical resistance thermometer (Foxboro Thermometer.) The temperature decreased gradually by about 0.2 to 0.5 degrees Centigrade per each 5 foot increase in depth from 0 to 105 ft. except for a decrease of 4.5°C. for the 5 ft. interval from the 20 to 25 ft. depth. The temperature at the surface was 29.0°C. and at a depth of 105 ft. it was 16.4°C.

On July 28, 1952 the temperature profile was again determined for 10 ft. intervals in depth from 0 to 110 ft. at S-239.1. No large change in temperature decrease occurred for any 10 ft. interval in this range. The water temperature at the surface was 31.7°C. and that at a depth of 110 ft. was 20.0°C.

SAVANNAH RIVER WATER TEMPERATURE IN AUGUSTA CANAL AT AUGUSTA, GEORGIA

Various temperature groupings are used in summarizing the temperature data obtained from the Augusta Water Department, Augusta, Georgia.

The air and water temperature as obtained from the Water Department consisted of 6 readings each, taken at 4 hour intervals during a 24 hour period. The daily temperatures used in the histogram and plots of air and water temperatures were an average of 6-4 hour readings.

Distribution in groups of 4 degrees Fahrenheit of the mean daily water temperatures is shown in the histogram in Figure 27. For almost 20 per cent of the days or more than 60 days of the year's period, February 4, 1951 to February 3, 1952, the water temperature at the Augusta Water Intake was in the 82° to 86° F. group. For less than 10 days the water temperature was in the 62° F. to 66° F. group. Of interest is the 38° to 42° F. temperature group in which there were only 9 days.

Savannah River water temperatures as might be expected of a relatively shallow stream, follow rather closely a running average of the mean daily air temperatures of the preceding seven days. Plots of the mean daily water temperature, running average of the preceding seven days mean air temperatures and the running average of the preceding seven days mean water temperature are shown in Figure 26. The water temperatures taken in the Augusta Canal by the Water Department should be practically the same as that in the Savannah River at Augusta since the point in the Augusta Canal at which the temperatures were read are only a short distance from where the Savannah River water enters the Augusta Canal.

Plots of the daily flow of the Savannah River at Augusta, Georgia, and the daily-average water temperature of the Augusta Canal are shown in Figure 25 for comparison purposes. Though it appeared that there is some negative correlation between flow and water temperature, flow does not

have nearly the effect of air temperature. The effect on water temperature by flow is transmitted through depth changes. An increase in depth diminishes the effect of air temperature. A decrease in depth causing increased turbulence in streams with rough bottoms will increase the effect of air temperature.

CHAPTER VI

BIOLOGICAL STUDIES

In fulfilling the objectives set forth in the introduction, investigations were undertaken to obtain information on the biota present in various habitats in the Savannah River. A comparison of the results of future biological studies with the background information presented here should aid in detecting and evaluating changes that might occur in the river. Limitations of time and personnel prevented these studies from being all-inclusive. With the exception of the work on plankton, most attention was given macroscopic forms which were most readily collected. Those groups of organisms which appeared to be most important in the biology of the river or of most interest to man were given special attention. Nearly all of the biological work was confined to the strictly fresh-water portion of the river. Thesobservations made on the estuarine portion of the river are treated separately at the end of the biological section.

FRESH-WATER ENVIRONMENTAL ASSOCIATIONS

The groups of organisms associated with the various habitats represented in the fresh-water sections of the Savannah River encompassed by this study may be classified and briefly defined as follows:

1. Plankton - organisms floating or drifting in the water which are not dependent upon a fixed substrate for their existence and organisms which may be normally attached but which have

been swept from their substrate and mixed with the true plankton. The plankton consists largely of the free-floating algae and of a variety of small invertebrates.

2. Benthos - organisms which are more or less dependent upon a solid substrate which is usually fixed but which may, on occasion, be shifting, drifting or floating. This group consists mainly of the insects, oligochaeta, mollusks and certain other invertebrates, and of attached algae. Many benthic organisms may be further subclassified on the basis of the type of substrate which they occupy. These organisms also differ in their manner of association with the substrate; some attach to it, others burrow into it, and others simply move about its surface.

A number of distinct types of habitats for benthonic organisms were present in the river. Separate associations of organisms inhabited different types of substrates; among which were:

a. masses of attached algae
b. compact clay
c. sand
d. mud
e. fixed organic debris (i.e. brush, trees, roots, etc.)
f. rock and gravel

3. Nekton - swimming organisms which are able to move about freely and which can maintain themselves against the current. The most important organisms in this group are the fish. Some large, free-swimming crustacea also belong in this assemblage.

Each of these groups of organisms is dealt with separately in the following section on presentation of results. Details of methodology are

also included here since these varied from group to group.

Plankton

Preliminary collections of plankton taken from the Savannah River in 1951 showed that the plankton population of the river was quite low. Concentrates of river water made in 1951 contained so much silt and so few organisms that quantitative analyses of them were not considered feasible. No extensive sampling for plankton was conducted prior to April 1952. At that time, plankton net tows made in Clark Hill Reservoir showed a sizeable zooplankton population. A sampling program was initiated to determine the fate of the Clark Hill Reservoir plankton populations in the Savannah River downstream from the reservoir.

During the period April 11-14, 1952 quantitative net plankton samples were taken at various depths from two stations (S-239.1 and S-238.0), in the reservoir and from the Savannah River at two stations (S-237.8 and S-219.2), below the reservoir. (Table 6). During the period May 1-5, 1952 quantitative net plankton and nannoplankton 1/ samples were taken at various depths from one station (S-239.1) in the reservoir, and from ten stations in the river below the reservoir, S-237.8, S-219.2, S-219, S-218.4, S-203.1, S-202.9, S-201.65, S-147.0, S-146.4, and S-143.5. (Table 8).

The net plankton samples collected in April 1952 showed a fairly abundant zooplankton population in Clark Hill Reservoir, consisting

1/ Nannoplankton consists of those organisms small enough to pass through a standard plankton net with #20 silk bolting cloth.

largely of microcrustacea and rotifers. (Table 6). The greatest concentrations of these organisms were in the surface waters, both in the main body of the reservoir and in the arm of the reservoir that was sampled. The samples taken from the Savannah River below the reservoir at this time showed the zooplankton in the river to be much less abundant than that in the reservoir. The water then being discharged to the river was drawn largely from the lower levels of the reservoir, where the plankton was relatively low.

In contrast to the fairly high zooplankton in the reservoir, the net phytoplankton was extremely low; the total numbers of these organisms were never as much as 1,000 organisms per liter. Net plankton and nannoplankton samples were collected simultaneously in order that the total plankton could be evaluated.

The series of net plankton samples taken in May showed an apparent decrease from April in the total numbers of zooplankton present in Clark Hill Reservoir, but a sizeable population still remained. (Table 7). The zooplankton population in the river downstream from the reservoir remained low, the zooplankton varying from 18 to 55 per liter at different stations.

The net phytoplankton populations in the reservoir remained small in May. In only one instance was the density as great as 1,000 organisms per liter. This paucity of net phytoplankton extended downstream from the reservoir with the only significant variation being noted in the oxbow at mile 146.4, where the net phytoplankton count was more than seven times the number of net phytoplankton organisms found anywhere else in the

TABLE 6 -- CLARK HILL RESERVOIR AND SAVANNAH RIVER NET PLANKTON ORGANISMS PER LITER
APRIL 1952

Date	4/11/52										4/14/52
Location	CLARK HILL RESERVOIR									SAVANNAH RIVER	
River Mile	S-239.1						S-238.8*			S-237.6	S-219.2
Depth	Surface	3'	25'	50'	75'	100'	Surface	3'	25'	40'	
MYXOPHYCEAE											
Blue-Green unicells				2	3						
TOTAL				2	3						
BACILLARIOPHYCEAE											
Melosira											13
Others						3					2
TOTAL						3					15
CHRYSOPHYCEAE											
Mallomonas			2		6	31		3			
TOTAL			2		6	31		3			
CHLOROPHYCEAE											
Eudorina	77	71	17		9	6	6	9	2		
Others	41	3	17	6	12	18			7		4
TOTAL	118	74	34	6	21	24	6	9	9		4
EUGLENOPHYCEAE											
Trachelomonas	22		17	7	3	6			19		
Others						12					4
TOTAL	22		17	7	3	18			19		4
DINOPHYCEAE											
Glenodinium	6		19	15	3				4		
Others	18										
TOTAL	24		19	15	3				4		
TOTAL NET PHYTOPLANKTON	164	74	72	30	36	76	6	12	32		23

TABLE 5 (Continued)

PROTOZOA												
Actinopoda			2									
Difflugia	95		7	17	3	22			2			
Ciliata	22		37	5	22	22			30			32
TOTAL	47		46	26	25	44			32			32
ROTATORIA												
Keratella	205	102	13	26	52	116	149	149	13	4	11	4
Polyarthra	35	53	2	4		3		40	4	2		2
Others	59	3	4	2	34	5	6	34	2			4
TOTAL	329	158	25	32	56	124	155	223	19	6	11	10
NEMATODA						3						
TOTAL						3						
CRUSTACIA												
Bosmina	12	9					6	9		2		
Cyclopsis	12					5	3					
Daphnia	18	59		8	3	6	3	3				2
Cyclops	108	158	2	2			99	40	4		4	4
Diaptomus	16	3						3		2		6
Nauplii	288	254	13	13	31	12	205	112	9	6	22	
TOTAL	442	483	15	17	34	27	322	167	13	10	26	12
TOTAL NEW ZOOPLANKTON	821	641	87	75	155	198	477	390	64	16	37	54

*Small Arm of the Reservoir. Estimated to be at S-238.8

TABLE 7 -- CLARK HILL RESERVOIR AND SAVANNAH RIVER NET PLANKTON ORGANISMS PER LITER
MAY 1952

Date	5/1/52						5/2/52							5/5/52		
Location	CLARK HILL RESERVOIR						SAVANNAH RIVER									
River Mi.	S-239.1						S-237.8	219.2	219	218.4	203.1	202.9	201.65	S-147.0	146.4	145.5
Depth	Surface	3'	25'	50'	75'	100'	Surface	3'	3'	3'	3'	3'	3'	3'	3'	3'
MYXOPHYCEAE																
Chroococcus		14											1			6
Others													1			6
TOTAL		14														
BACILLARIOPHYCEAE																
Melosira			3	4	6		2	3	17	43	1	6	2	17	817	37
Others		18	6	4				5	82	4	8	10	19	41	266	93
TOTAL		18	9	8	6		2	8	99	47	9	16	21	58	1083	130
CHRYSOPHYCEAE																
Dinobryon		19							54		21		4	15	14	3
Mallomonas		218									3		1			3
Synura		9														
TOTAL		246							54		24		5	15	14	6
CHLOROPHYCEAE																
Eudorina								2	2	1						
Others	5	5		8		2		2	8		9	4	5	6	14	9
TOTAL	5	5		8		2		4	10	1	9	4	5	6	14	9
EUGLENOPHYCEAE																
Trachelomonas	5	37			124	6			4				1		56	9
Others	5					4					4	5	1		7	
TOTAL	10	37			124	10			4		4	5	2		63	9
DINOPHYCEAE																
Glenodinium		[illegible]		8	983	56	13		2		1				84	
Others					6	2		1		4						
TOTAL		[illegible]		8	989	58	13	1	2	4	1		3		84	
TOTAL NET PHYTOPLANKTON	15	346	9	24	1119	70	15	13	169	52	47	25	37	79	1258	160

TABLE 7 (Continued)

PROTOZOA																
Difflugia			3		6	4	9			3		5		6	14	6
Ciliata		5				4	5	2	11		6	7	1	2	7	3
TOTAL		5	3		6	8	14	2	11	3	6	12	1	8	21	9
ROTATORIA																
Keratella	56	223	11		5	2	5		6		3		5	2		9
Polyarthra	88	88	3	4		2		1		1	1	2	3			
Others	88	125						22	23	10	1	11	7	2		12
TOTAL	232	436	14	4	5	4	5	23	29	11	5	13	15	4		21
NEMATODA																
TOTAL													4			
													4			
CRUSTACEA																
Bosmina			3			4	2									
Chydorus			3													
Daphnia	28	53	3	1		12	7	4	2							
Cyclops	93	58	3			13	7	5		3	1	3				3
Diaptomus	14	19				2										
Nauplii	130	116	42		19	28	7	8	13	9	6	2	1	11	28	16
TOTAL	265	247	57	1	19	66	23	17	15	12	7	5	1	11	28	19
INSECTA																
Tentidedidae														2		
TOTAL														2		
TOTAL NET ZOOPLANKTON	497	688	74	5	31	78	42	42	55	26	18	30	21	25	49	49

* Ox-Bow at S-146.4.

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stretch of river sampled. This count was still only 1,258 organisms per liter, or slightly more than one organisms per milliliter. This increase in net phytoplankton was not reflected in the sample from the river below the ox-bow (mile 145.5); the net phytoplankton there was only 160 organisms per liter.

Nannoplankton was also extremely rare in the river. (Table 8). Nannophytoplankton for each station was added to the net phytoplankton to attain the total numbers of phytoplankton. The total phytoplankton (Table 9) of the river showed no significant changes over the stretch of river studied, varying from 3,200 to 6,200 organisms per liter at different stations.

The plankton populations in Clark Hill Reservoir did not appear to influnce the plankton populations in the river to any considerable extent, during April and May 1952. The sampling errors involved in dealing with such small numbers of organisms would make it impossible to detect any such influence unless it occurred to a marked degree. Some of the organisms comprising the river plankton appeared to be contributed by Clark Hill Reservoir, while others apparently entered the river from other sources such as sloughs, ox-bows, and tributaries draining the flood plain. Diatoms, in particular, appeared to be multiplying in the river, or entering it from some source other than Clark Hill Reservoir. Eleven genera of diatoms were identified in the river plankton, and only five of these were found in Clark Hill Reservoir. (Table 10). The total numbers of diatoms were consistently higher in the nannoplankton counts from the river than they were in the counts from the reservoir. This was also generally true of the diatoms in the net plankton. The limited

data from mile 146.4 indicated that some of this slight increase in diatoms may have originated in ox-bows on the river.

The only major pollution entering the stretch of river sampled for plankton was the sewage from Augusta which is discharged to the river at two points. The sewage from about 15% of the population entered the river at mile 215, and the remainder of the sewage entered the river through Butler Creek at mile 202.65. Plankton samples taken downstream from these points at miles 203.1 and 201.65, respectively, did not show any detectable quantitative changes in the total phytoplankton. Such increases would ordinarly be expected, due to the fertilizing effects of organic pollution; however, the low transparency of the river water was probably a limiting factor in these areas.

It is expected that Clark Hill Reservoir will continue to contribute some organisms to the plankton of the river, but it is difficult to determine to what extent future increases in the plankton of the reservoir will be reflected in the plankton of the river downstream. Any lowering of turbidity in the river, brought about by settling of suspended silt in Clark Hill Reservoir would undoubtedly improve conditions for the survival and reproduction of plankton populations in the river.

Benthos

Benthic Algal Growths and Associated Organisms

The low transparency of the water and the extreme variation of water levels prevalent at the time of the present studies apparently limited the growth of attached algae in the river. Masses of attached algae were observed, however, during the few periods of stable water

Date	5/1/52						5/2/52							5/5/52		
Location	CLARK HILL RESERVOIR						SAVANNAH RIVER									
River Mi.	S-239.1						S-237.8	219.2	219	218.4	203.1	202.9	201.65	S-147.0	146.4*	145.5
Depth	Surface	3'	25'	50'	75'	100'	Surface	3'	3'	3'	3'	3'	3'	3'	3'	3'
MYXOPHYCEAE																
Chroococcus				5	2				5	3	2	5		5		
Others									5					7		
TOTAL				5	2				10	3	2	5		12		
BACILLARIOPHYCEAE																
Gyrosigma								5	5	1		5		2		
Melosira	5				2		7		7	3	2	5		7		5
Navicula		2			2			7	7	18	5	11	14	5		11
Nitzschia								2	2		2	5				5
Synedra	9	23	2	14	5		20	18	11	12	14	29	41	9		24
Others				2				2		4	2			7		
TOTAL	14	25	2	16	9		27	34	32	35	25	55	55	30		45
CHLOROPHYCEAE																
Chlamydomonas group	5		7	5	5	9	2	2		6	2			2		
Others	2	2		2	2				5	1				11		
TOTAL	7	2	7	7	7	9	2	2	5	7	2			13		
EUGLENOPHYCEAE																
Euglena	7	9	2				5		5			2	5	5		3
Trachelomonas	5	2				2					2			2		
TOTAL	12	11	2			2	5		5		2	2	5	7		3
DINOPHYCEAE																
Glenodinium	34	18		2			5	2								
Others																
TOTAL	34	18		2			5	2								
TOTAL NANNOPLANKTON	67	56	11	30	18	11	39	38	52	45	31	62	60	60		48

* Ox-Bow at S-146.4. Nannoplankton sample lost.

TABLE No. 9

CLARK HILL RESERVOIR AND SAVANNAH RIVER

TOTAL PHYTOPLANKTON ORGANISMS PER LITER

DATE	LOCATION	RIVER MILE	DEPTH	TOTAL NET PHYTO-PLANKTON	TOTAL NANNO-PHYTO-PLANKTON	TOTAL PHYTO-PLANKTON
			Surface	0	6700	6700
	Clark		3'	400	5600	6000
5/1/52	Hill	S-239.1	25'	0	1100	1100
	Reservoir		50'	0	3000	3000
			75'	1100	1800	2900
			100'	100	1100	1200
		S-237.8	Surface	0	3900	3900
		S-219.2	3'	0	3800	3800
		S-219	3'	200	5200	5400
	Savannah	S-218.4	3'	100	4500	4600
5/2/52	River	S-203.1	3'	100	3100	3200
		S-202.9	3'	0	6200	6200
		S-201.65	3'	0	6000	6000
		S-147.0	3'	100	6000	6100
5/5/52		S-146.4*	3'	1300	--	--
		S-145.5	3'	200	4800	5000

* Ox-Bow at S-146.4. Nannoplankton sample lost.

TABLE NO. 10

ORGANISMS FOUND IN CLARK HILL RESERVOIR AND SAVANNAH RIVER PLANKTON
APRIL-MAY 1952

ORGANISMS	SAVANNAH RIVER		CLARK HILL RESERVOIR	
	APRIL	MAY	APRIL	MAY
MYXOPHYCEAE				
Chroococcus		x		x
Oscillatoria group		x		
Phormidium		x		
Undetermined unicells		x		
BACILLARIOPHYCEAE				
Asterionella		x		
Ceratoneis		x		
Cyclotella		x		x
Cymbella		x		
Fragilaria		x		
Gomphonema	x	x		x
Gyrosigma		x		
Melosira	x	x		x
Navicula		x		x
Nitzschia		x		
Synedra		x		x
Undetermined Pennales		x	x	x
CHRYSOPHYCEAE				
Dinobryon		x		
Mallomonas		x	x	x
Synura				x
CHLOROPHYCEAE				
Ankistrodesmus		x		
Cerasterias		x	x	x
Chlamydomonas		x		x
Closterium		x		
Coelastrum		x	x	
Cosmarium		x		
Desmidium		x		
Eudorina			x	
Gloeocystis			x	
Micractinium			x	
Oedogonium		x		
Oocystis			x	
Pandorina			x	
Pediastrum			x	
Pleodorina		x	x	

TABLE NO.10 (continued)
ORGANISMS FOUND IN CLARK HILL RESERVOIR AND SAVANNAH RIVER PLANKTON
APRIL-MAY 1952

ORGANISMS	SAVANNAH RIVER		CLARK HILL RESERVOIR	
	APRIL	MAY	APRIL	MAY
CHLOROPHYCEAE (continued)				
Scenedesmus				x
Stigeoclonium		x		
Tetraedron	x			
Volvox		x	x	x
Volvocales cysts		x		x
EUGLENOPHYCEAE				
Euglena		x		x
Trachelomonas		x	x	x
Undetermined Euglenophyceae	x	x	x	x
DINOPHYCEAE				
Ceratium			x	
Glenodinium		x	x	x
Peridinium		x	x	x
PROTOZOA				
Difflugia		x	x	x
Actinopoda			x	
Undetermined Ciliata	x	x	x	x
NEMATODA		x	x	
ROTATORIA				
Conochilus		x	x	x
Keratella	x	x	x	x
Monostyla		x	x	
Notholca		x	x	
Polyarthra	x	x	x	x
Undetermined Rotatoria	x	x	x	x
Rotifer eggs		x		
CRUSTACEA				
Bosmina		x	x	x
Chydorus			x	x
Daphnia	x	x	x	x
Cyclops	x	x	x	x
Diaptomus			x	x
Nauplii	x	x	x	x
INSECTA				
Tendipedidae		x		

levels. Even on these occasions the vertical zone wherein effective photosynthesis could occur was quite narrow. Substrates such as floating debris, willow branches, and roots, which could rise and fall with the water level keeping the algae near the surface, supported algal growths for longer periods than fixed substrates. Algal growths on fixed substrates were often stranded by receding water or kept below the photosynthetic zone by rising water.

Periods of algal abundance which persisted for intervals of several weeks were observed during the winter, spring and summer of 1952. They were attributed to extended periods of relatively stable water levels. The filamentous green alga, Stigeoclonium lubricum, was the most abundant species observed during the winter and spring of 1952. It was often found growing in long streamers attached to willow branches in swift water. The red alga, Audouinella, and the filamentous green algae, Oedogonium and Vaucheria, were frequently found in similar situations. Other genera of algae sometimes found in abundance were the diatoms, Fragilaria, Tabellaria, and Melosira; the green algae, Chaetophora, Microspora and Tetraspora; and the blue-green alga, Oscillatoria. Some of these species preferred quieter waters and were found in flooded swamp areas and back waters rather than in the river proper. Spirogyra became extremely abundant during the summer, when it was often found in quiet areas sheltered by sand bars. Phormidium was observed throughout the year growing in closely adherent mats on submerged sticks and logs and on shallow sand bars. Seasonal changes in the composition of the algae were probably caused by increased water temperatures which created unfavorable conditions

for the species predominating earlier in the year and favored warm water species.

Filamentous algae growing in fast water were generally found in almost pure stands, while the algae growing in quieter water often had many other organisms growing in association with them. For example, protozoans, rotifers, nematodes and oligochaeta were often found abundantly living in association with the algae in stagnant areas. Masses of Stigeoclonium, Vaucheria, and Audouinella growing attached to willow branches in fast water at S-165.4 collected on January 1, 1952 contained sizeable populations of insects. This fauna was largely composed of the immature stages of mayflies (Ephemerella sp.), midges (Spaniotoma sp.) and caddis flies (Leptocella sp.). Other immature insects present were stoneflies (Hydroperla harti), caddis flies (Macronemum carolina, Hydroptila sp. and undetermined Psychomiidae), midges (Polypedilum sp. and Tanytarsus dissimilis), snipe flies (Atherix variegatus) and beetles of the family Elmidae.

Twelve samples of algal masses were collected from the river at S-171.62; S-170.5; S-169.0; S-165.4; S-155.3; S-152.0, and S-146.4 and from Upper Three Runs on April 18, 1954 for critical examination of the invertebrate fauna associated with them. The water level was high at that time, and an area for some distance upstream from the mouth of Upper Three Runs was innundated by Savannah River water. Samples of algal masses were taken at the mouth of this tributary, S-171.59, UTR-.1, and two miles upstream from the river backwater at S-171.59, UTR-200. A single algal mass was collected from the river on May 12, 1952 and another one on July 23, 1952 at S-155.3 and S-169.0. These algal masses were brought into the

TABLE 11 - SAVANNAH RIVER STUDIES
ALGAL-MASS ALGAE

Location(River) Mile)	S-171.62	S-171.59 Ut-2.0	S-171.59 Ut-0.1	S-171.59 Ut-0.1	S-171.59 Ut-2.0	S-171.59 Ut-0.1	S-171.59 Ut-0.1
Date (1952)	4/18/52	4/18/52	4/18/52	4/18/52	4/18/52	4/18/52	4/18/52
Predominant Algae	Stigeoclonium lubricum	Melosira italica, Fragilaria sp.	Vaucheria polysperma, Stigeoclonium lubricum	Melosira sp, Stigeoclonium lubricum,	Melosira italica, Oedogonium sp; Fragilaria sp;	Stigeoclonium lubricum	Stigeoclonium lubricum, Spirogyra sp, Vaucheria sp.
Other Algae present	Lyngbya sp.	Asterionella sp, Frustulia vulgaris, Tabellaria flocculosa, Navicula sp, Eunotia sp, Closterium sp, Oedogonium sp, Tetraspora sp, Anabaena sp, Oscillatoria sp, Undet. Euglenophyta	Navicula sp, Ulothrix sp, Spirogyra sp; Fragilaria sp; Oedogonium sp, Melosira sp, Lyngbya sp.	Vaucheria sp, Spirogyra sp, Fragilaria sp; Oedogonium sp; Mougeotia sp, Navicula sp.	Navicula sp, Eunotia sp, Synedra sp, Ankistrodesmus sp, Desmidium sp, Mougeotia sp, Ulothrix sp, Anabaena sp, Oscillatoria sp.	Zygnema sp, Tetraspora sp;	Fragilaria sp, Eunotia sp, Melosira sp, Lyngbya sp, Tetraspora sp.
Weight of Algal Mass(grams)	13.2	---	15.8	22.9	2.7	24.5	19.[illegible]

TABLE 11 - (Continued)

Location (River) Mile)	S-170.5	S-170.5	S-169.0	S-165.4	S-155.3	S-152.0	S-146.4
Date	4/18/52	4/18/52	7/23/52	4/18/52	5/12/52	4/18/52	4/18/52
Predominant Algae	Vaucheria polysperma	Stigeoclonium lubricum	Spirogyra sp.	Stigeoclonium lubricum	Oedogonium sp	Stigeoclonium lubricum, Melosira sp.	Oedogonium spp, Fragilaria sp.
Other Algae present		Oedogonium sp., Gomphonema sp., Lyngbya sp., Tetraspora, Vaucheria sp, Melosira sp, Tabellaria sp.	Schizomeris sp.	Oedogonium sp; Melosira sp.		Fragilaria sp; Spirogyra tenuissima, Eunotia sp.	Stigeoclonium, lubricum, Fragilaria sp., Eunotia sp., Melosira sp, Oscillatoria sp.
Weight of Algal Mass (grams)	46.7	41.3	80.2	---	2.7	14.[illegible]	3.[illegible]

TABLE 12 - SAVANNAH RIVER STUDIES
ANIMALS ASSOCIATED WITH ALGAL MASSES

Location (River Mile)	S-171.62	171.59	171.59	171.59
		Ut-2.0	Ut-0.1	Ut-0.1
Date (1952)	4/18/52	4/18	4/18	4/18
ANNELIDA: OLIGOCHAETA				
Nais communis, *Nais josinae*, Undet. Nais			83	
Naidium sp.				
Pristina aequiseta			46	
Stylaria fossularis, *Stylaria proboscidea*.				12
Undet. Naididae		3	4	51
Undetermined				
ARTHROPODA: CRUSTACEA				
Copepoda: *Cyclops* sp., *Diaptomus* sp.				
Ostracoda: Undetermined				
Cladocera: *Daphnia* sp.				
Ceriodaphnia sp.				
Eurycercus lamellatus, *Acroperus harpae*, *A. angustatus*, *Pleuroxsus denticulatus*		71	1	
Amphipoda: *Crangonyx gracilis*				
ARTHROPODA: ARACHNIDA				
Hydracarina: Undetermined				1
ARTHROPODA: INSECTA				
Plecoptera: *Perlesta placida*				
Isoperla bilineata				1
Ephemeroptera: *Stenonema* sp.				
Caenis sp.				
Ephemerella spp. *invaria* gr.				
Leptophlebia sp.				
Undet. Baetinae				3
Odonata: *Neurocordulia* sp.				
Neuroptera: *Corydals cornutus*				
Trichoptera: *Hydropsyche simulans*, Undet. Hydropsyche				
Macronemum carolina				2
Leptocella candida				
Triaenodes nr. *injusta*				

(continued)

TABLE 12 (Continued) - SAVANNAH RIVER STUDIES
ANIMALS ASSOCIATED WITH ALGAL MASSES

S-171.59	171.59	171.59	170.5	170.5	169.0	165.4	155.3	152.0	145.4
Ut-2.0	Ut-0.1	Ut-0.1							
4/18	4/18	4/18	4/18	4/18	4/18	4/18	5/12	4/18	4/18
						1			
							22		
							4		
							1		
		1							
							17		
						3			
1		2							
									24
									4
									3
									1
									2039
							1		
						1			1
							10		
		1		1					
						4			
1									
				1					
							1		
						73			
1		5				3			
				1					

(continued)

TABLE 12 (Continued) - SAVANNAH RIVER STUDIES
ANIMALS ASSOCIATED WITH ALGAL MASSES

Location (River Mile	[illegible]-171.62	171.59	171.59	171.59
		Ut-2.0	Ut-0.1	Ut-0.1
Date (1952)	4/18/52	4/18	4/18	4/18
ARTHROPODA: INSECTA (Continued)				
Coleoptera: *Stenelmis* sp.				4A**
Macronychus glabratus				5A
Undet. Hydroporinae				
Gyrinus sp.				[illegible]
Tropisternus sp.				
Diptera: *Atherix variegata*				
Ablabesmyia carnea				
Ablabesmyia monilis				
Undet. *Ablabesmyia*				
Ablabesmyia flavifrons or *melanops*				
Ablabesmyia pilosella				
Procladius sp.		1		
Corycneura scutellata(?)*C.* spp.	1		1	
Thienemanniella sp.	1		10	3
Spaniotoma sens.lat.spp.	21[illegible]	[illegible]	242,6[illegible] *	472
Psectrocladius sp.				
Tanytarsus nr. *dissimilis*		2		
Tanytarsus sens.lat.spp.				
Microspectra sp.				
Microtendipes pedellus				
Polypedilum illinoiense	3			
Undet. *Polypedilum*		[illegible]	1[illegible]	5
Endochironomus nigricans				3
Limnochironomus modestus				
Undet. Chironominae				
Palpomyia spp.				
Stilobezzia sp.				
Undet. Ceratopogonidae			[illegible]	
MOLLUSCA: GASTROPODA				
Undet. Planorbidae				
TOTAL ORGANISMS	2[illegible]7	[illegible]	412	567

* [illegible] = Pupa

** [illegible] = Adult

2 OF 3
PB
229 203

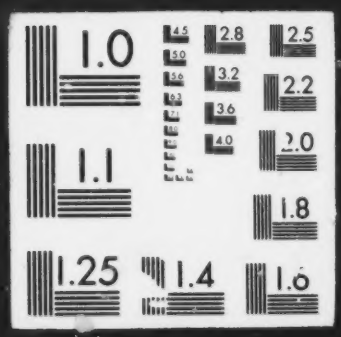

TABLE 12 (Continued) - SAVANNAH RIVER STUDIES
ANIMALS ASSOCIATED WITH ALGAL MASSES

S-171.59 Ut-2.0 4/18	171.59 Ut-0.1 4/18	171.59 Ut-0.1 4/18	170.5 4/18	170.5 4/18	169.0 7/23	165.4 4/18	155.3 5/12	152.0 4/18	140.4 4/18
			1A**		2		8		
				1					
							1		
							1		
			1	1					
							1		
					101P*		10		
				1				1	
2			1						
					1				
									5
	109	3	1	41		1	110,3P	7	1
			2			17			5
3	706	170	203,5P	772	129,20P	94	415,4P	435	90
						11			
									1
					35,1P			2	
									1
									1
				2				111	
2	2	1	14		8	7	242,1P	15	
				1				3	4
					29,1P				
			11					31	
									4
		1							
1									
11	817	175	244	822	310	214	847	605	2191

* P = Pupa

** A = Adult

laboratory where the animals were separated from them. The algae were then identified, blotted dry, and weighed. The animals were preserved and later identified. The data from these determinations are recorded in Tables 11 and 12. The algal masses collected from the river and from the mouth of Upper Three Runs were all heavily populated with animal life. The sample from Dead River at S-146.4 had large numbers of microcrustacea present, but in all other cases chironomid larvae were the most abundant organisms. Spaniotoma was by far the most common chironomid genus present in all these algal masses. While Spaniotoma spp. were found widely distributed in brush box samples and bottom samples, they are principally algal feeders and were never found elsewhere in the high numbers that they attained in algal masses.

The samples collected from the area above the backwater (station) on Upper Three Runs showed much lower animal populations than the other samples in this series. Most of the algae in these particular samples were in a partially decayed condition, possibly because the growth of foliage on the trees had shaded many areas of the stream previously exposed to sunlight. The lower numbers of insects may be attributed to the fact that the decaying algae formed an unsuitable habitat for algal feeders such as Spaniotoma.

Any clarification of river water and stabilization of water levels which should result from the operation of Clark Hill Reservoir would increase the opportunities for the development of benthic algae by widening the photosynthetic zone, and would reduce the periodic stranding or submersion of the algae. These conditions would also result in increased numbers of algal-feeding invertebrates.

Organisms Associated with Compact Clay

On the outer side of every meander of the river and at many places between meanders, the banks of the river are quite steep and composed of compact clay. Wherever this clay which underlies the soil of the flood

plain, or wherever the resistant clays and marls of the Coastal Plain sediments are exposed to the current of the river, these substrates are literally honey-combed with the burrows of mayfly nymphs. The mayfly nymphs and the organisms found in their abandoned burrows form a characteristic assemblage of organisms that is to be found abundantly throughout the Coastal Plain portion of the river. Bottoms of clay, present where steep clay banks had crumbled into the river, had the same burrowing mayfly fauna as was found on the clay banks themselves.

Since the substrate occupied by these organisms is always rather hard, nearly always vertical, and is usually exposed to swift water, it is exceedingly difficult to sample adequately. A number of qualitative collections were made from these clay banks at miles S-171.7, S-165.5, and S-154.6 during June and July 1952. On July 30, 1952 a quantitative sample was taken from a clay bank at S-52.0. A block of clay was removed from the bank and its volume was measured by displacement. It was then broken up and washed through a series of screens. The organisms were picked out, identified, counted, and their volume determined by displacement.

Nymphs of the burrowing mayfly, Tortopus, were the most abundant organisms encountered in the qualitative collections. A variety of other organisms was also present. It is believed that the quantitative collection from S-52.0 recorded in Table 13 is fairly representative of compact clay substrates throughout the Coastal Plain portion of the river. In this collection Tortopus nymphs comprised 54% of the total number of organisms present and 94% of the total volume. Many of the Tortopus

nymphs appeared to be about to emerge as adults (i.e. in their last nymphal instar). Thus, the population of this species of organism might be assumed to be near its maximum volume.

The strategic location of these mayfly burrows at just the points where the current of the river impinges upon a firm substrate, undoubtedly aids the erosive action of the river against banks that would otherwise be very resistant to such attack. One peculiar feature of Tortopus is its apparent migratory nature. On many banks, abandoned mayfly burrows were found in abundance five or six feet above low water levels while both occupied and unoccupied burrows were at the same time found at least six feet below the water surface. Since the uppermost of these burrows could only have been occupied for a relatively short part of the nymphal life of a mayfly, it seems obvious that some individuals must move about in this honey-comb, building new burrows or occupying old ones above the normal water levels while the river is high, and retreating to succeedingly lower ones as the river drops. Considering the area of exposed surface represented, the numbers and volume of organisms taken from the quantitative sample were high. The organisms found in association with Tortopus do not usually burrow in hard clay themselves and the burrowing activities of the mayflies provided them with a suitable habitat. This one quantitative sample indicates that large populations of organisms are present in this habitat. This assumption is substantiated by the qualitative sampling of clay banks elsewhere in the river which appeared to parallel this one very closely. Since clay banks are present at many places on the

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TABLE 13 - QUANTITATIVE CLAY BANK SAMPLE S-52.0
SAVANNAH RIVER STUDIES
JULY 30, 1952

Volume of clay substrate - 8,000 cc., Area of Exposed surface 1,600 cm^2

		Number	Volume (cc.)
ORGANISMS			
Nematoda:	Undetermined	107	0.05
Arthropoda, Insecta */			
Plecoptera:	Acroneuria sp.	4	0.05
Ephemeroptera:	Tortopus sp. last instar	57	4.80
	Tortopus sp. other instars	457	22.40
	Stenonema spp.	18	0.02
	Isonychia spp.	99	0.24
	Tricorythodes sp.	4	0.00
	Caenis spp.	5	0.01
	Baetinae, undetermined	1	0.00
Odonata:	Cordulinae, undetermined	1	0.00
	Argia sp.	1	0.00
Neuroptera:	Corydalis cornutus	5	0.80
Trichoptera:	Cheumato psyche sp.	5	0.00
	Macronemum carolina	15	0.15
	Macronemum carolina, pupa	1	0.04
	Potamyia flava	1	0.00
Coleoptera:	Stenelmis decorata, adult	117	0.17
	Stenelmis sp., larva	26	0.05
Diptera:	Palpomyia	1	0.00
	Pentaneura (monilis group)	4	0.00
	Chironomidae, undetermined	2	0.00
Mollusca			
Gastropoda:	Pleurocera sp.	15	0.10
Pelecypoda:	Sphaerium sp.	1	0.00
TOTAL		947	28.88

*/ Unless otherwise indicated, all Arthropoda were represented by immature forms.

river, this community of organisms, dominated by Tortopus, appears to be an important part of the Savannah River fauna.

Organisms Associated with Sand and Mud

The most extensive and widespread substrates available to benthic organisms in the Savannah River are the sands and silts of the river bottom proper. Much of this material is constantly undergoing erosion and deposition. Such instability greatly limits the potentiality of supporting any sizeable community of organisms.

Areas of sand and mud bottoms were often contiguous, or intermingled, and the same technique was necessarily used for sampling both; thus, these two types of substrate are herein considered together. Bottom samples were taken by Petersen dredge at miles S-223 (Stephens Creek Impoundment), S-203.3 (New Savannah Bluff Impoundment), S-201.55, S-171.7, S-165.5, S-146.4 (Dead River), S-141.0, and S-51.0.

Except in the case of the impoundments, which had fairly uniform bottoms, samples were taken in transects across the river. The spacing of the samples across each transect depended upon the rate of flow of the river and the nature of the bottom materials. Areas that appeared to be uniform with regard to bottom materials, depth, and current speed, were sampled but once on any given transect. The numbers of organisms collected from mud and sand substrates were generally small as compared with those taken from other substrates. The numbers of individuals and species present depended upon the nature of the bottom sampled. The areas of shifting sand, which formed the majority of the bottom materials in areas of swift current, were practically devoid of macroscopic

organisms. Bottoms of sand, mud, and organic debris such as those present in impoundments and backwaters, and other areas where deposition of silt was taking place, supported larger numbers and a greater variety of macroscopic organisms. Transects across the river at stations where the several different bottom types were present showed a fauna varying from one side of the stream to the other. (Table 14).

Midge larvae were the most ubiquitous organisms in the bottom fauna. Chironomids or Ceratopogonids were present in almost every bottom sample taken. The greatest numbers of chironomids and oligochaeta worms were taken from a sample on the Georgia side of the river at mile S-201.55, apparently reflecting the organic enrichment of the river by the sewage from Butler Creek. Several genera of burrowing mayflies other than Tortopus were collected, and the emergence of one of these genera was observed in July 1952. Large numbers of Hexagenia bilineata were seen swarming on willows above areas of soft mud bottom at miles S-146.4, S-141.0, and S-130.0.

Fresh-water mussels were moderately abundant as was evidenced by the numbers of dead shells along the shores. This important group of organisms was inadequately sampled by dredge. The low river levels prevailing during the fall of 1951 and the summer of 1952 made it possible to collect a number of living mussels by hand. In 1952 it was noted that large numbers of these animals were killed by being stranded in drying pools behind sand bars. Mussels have yet to be identified.

The populations of organisms living in sand and mud habitats were generally low, particularly in the areas of shifting sand. However, since these areas afford the most extensive habitats available to benthic

TABLE NO. 14 - SAVANNAH RIVER STUDIES

SUMMARY - - - Bottom Samples *

Sampling Point	S-223.0	S-203.3	S-201.55			
Date	8/23/51	9/25/51	8/1/52			
Depth (Feet)	6	8	3	2	9	9
Bottom Materials **	MS,OD	MS	MS,OD	SG,OD	S	S,OD
Number of Dredge Grabs	2	4	3	3	3	3
NEMATODA						
Undetermined						
ANNELIDA: OLIGOCHAETA						
Peloscolex sp.						
Undetermined		22		3		
ANNELIDA: HIRUDINEA						
Helobdella		2				
ARTHROPODA: INSECTA						
Ephemeroptera: *Ephemera* sp.						
Hexagenia sp.	6					
Tortopus sp.						
Pentagenia sp.						
Stenonema spp.						
Isonychia spp.						
Ephemerella sp.						
Caenis sp.						
Odonata: *Gomphus* sp.						
Argia sp.						
Neuroptera: *Sialis* sp.	1					
Corydals cornutus						
Trichoptera: *Chimarra aterima*						
Macronemum carolina				6		3
Undet. Hydroptilidae						8P
Leptocella sp.						1P
Coleoptera: *Macronychus glabratus*						
Stenelmis sp.				29		1

*/ All organisms represent larval forms except where indicated
A = Adult P = Pupa

**/ M = mud
S = sand
C = clay
G = gravel
OD = organic debris
P = *Phormidium*

(continued)

TABLE NO. 14 - SAVANNAH RIVER STUDIES (Continued)

SUMMARY - - Bottom Samples *

S-171.7				S-165.5			S-146.4				S-141.0					S-51.0			
7/23/52				7/21/52			11/12/51				7/10/52					7/31/52			
12	8	8	3	10	10	3	5	4	3	3	6	11	8	12	--	2	6	8	7
**C	SC,OD	S,OD	S	C,OD	S	S	M	M	M	M	MS,OD	SP	S	S	MS,OD	M,OD	S,OD	S,OD	C,OD
3	3	3	3	3	3	3	2	2	2	2	3	3	3	3	3	3	3	3	3
				1															
										2									
				1				7	9	1	22	3				11			
													1						
							2									4			1
149	7	1		9															1
		1		1														2	
1			1		1														
1																			
	1	1																	1
															1	2			
		1																	
		1																	
1																			2
10				1P														13	
																			1
																		2	
3,6A	6	2A		19,1A								1A						1A	

*/ All organisms represent larval forms except where indicated
A = Adult P = Pupa

**/ M = mud
S = sand
C = clay
G = gravel
OD = organic debris
P = Phormidium

(continued)

TABLE 14 - SAVANNAH RIVER STUDIES (continued)

SUMMARY - - Bottom Samples *

Sampling Point	S-223.0	S-203.3	S-201.55			
Date:	8/23/51	9/25/51	8/1/52			
Depth (Feet)	6	8	3	2	9	9
Bottom Materials **	MS,OD	MS	MS,OD	SG,OD	S	S,OD
Number of Dredge Grabs	2	4	3	3	3	3
ARTHROPODA: INSECTA (continued)						
Diptera: *Chaoborus* sp.		1P				
Ablabesmyia monilis						1
Ablabesmyia flavifrons						
Ablabesmyia pilosella	1		1			
Procladius sp.						3
Coelotanypus nr. *concinnus*						
Spaniotoma sens. lat. spp.						
Tanytarsus sens. lat. spp.						
Stenochironomus exquisitus	1					
Stenochironomus flavicingula	1					1
Polypedelium sp.		1				
Endochironomus tendens			9	1		
Cryptochironomus stylifer			2			
Cryptochironomus sp.			19			30
Limnochironomus modestus			84			
Parachironomus tenuicaudatus			8			
Limnochironomus sp.						
Chironomus sp.						
Undet. Chironomidae			1			
Undet. Ceratopogonidae						
MOLLUSCA: GASTROPODA						
Physa sp.						
Ferrissia sp.						
MOLLUSCA: PELECYPODA						
Pisidium sp.		1				
Sphaerium sp.		7				
Musculium sp.		4				
unionidae		1				
TOTAL ORGANISMS	10	39	124	39	0	48

*/ All organisms represent larval forms except where indicated
A = Adult P = Pupa

**/ M = mud
S = sand
C = clay
G = gravel
OD = organic debris
P - *Phormidium*

TABLE NO. 14 - SAVANNAH RIVER STUDIES (Continued)

SUMMARY - - Bottom Samples *

S-171.7				S-165.5			S-146.4				S-141.0					S-51.0			
7/23/52				7/21/52			11/12/51				7/10/52					7/31/52			
12	8	8	3	10	10	3	5	4	3	3	6	11	8	12	--	2	6	8	7
**C	SG,OD	S,OD	S	C,OD	S	S	M	M	M	M	MS,OD	SO	S	S	MS,OD	M,OD	S,OD	S,OD	C,OD
3	3	3	3	3	3	3	2	2	2	2	3	3	3	3	3	3	3	3	3
							4		2	4									
	1						2									2			
							1									5			
							16	12	15							1			
												2							
2																		2	1
												1				8			
	1				1							3	4					1	
												8	1			1			1
											1		1			1			
												2							
													1						1,1P
																3			
												8							
	6	2	7		1								1				1	9	
		1																	
		1																	
																			1
173	22	11	8	33	0	3	25	19	26	7	23	28	9	0	1	38	1	30	11

*/ All organisms represent larval forms except where indicated
A = Adult P = Pupa

**/ M = mud
S = sand
C = clay
G = gravel
OD = organic debris
P = phormidium

invertebrates, they must be considered somewhat more important in the productive economy of the river than the low densities of the organisms inhabiting them indicate.

Organisms Associated with Brush, Trees, Rocks, Gravel, etc.

Piles of tangled debris, formed by roots, fallen trees, brush and materials swept into the river from its flood plain and tributary streams, were abundant in the river. It was observed early in the study that these substrates often supported large and diverse populations of invertebrates. Natural outcroppings of sandstone and chert, and banks riprapped with granite also provide stable substrates for invertebrates. Such areas were not common.

Devices called "brush boxes" were constructed in order to obtain representative samples of the organisms occupying such substrates. (Appendix G). Table 15 presents summarized data of such collections; complete data are shown on Table 1, Appendix "G".

The use of brush boxes to sample benthic organisms has several advantages over random collection. Brush boxes may be set in almost any situation from which a sample is desired. Thus, the investigator is not dependent upon the chance occurence of suitable substrates at a location of particular interest and samples may be easily obtained from situations varying with regard to depth, current, bottom materials, proximity to strategic tributaries, and other considerations. The groups of organisms collected from boxes placed at different stations may be compared on a relative basis since the materials placed in the boxes offer similar substrates for colonization. Thus the species composition of the population

of any one insect group, for example, the diptera, may be compared from one box to another. Brush box sampling is apt to be less selective than some other methods of collecting since a given amount of the substrate material from a definable environmental situation is examined in detail regardless of the paucity or richness of the fauna.

The limitations encountered in the use of brush boxes were primarily due to the loss and silting-in of boxes. If the wires holding the boxes were fixed to the bank below the water surface, where they could not be seen and tampered with by curious persons, a rise in the river level made them difficult to find and recover. Boxes placed in strong current risked being carried away completely, as they became clogged with drifting debris, while those placed in very sheltered situations occasionally became deeply covered by silt.

In order to establish a standard time interval of convenient length during which a representative fauna could accumulate, a series of four boxes was set side by side at mile S-219 on July 23, 1951, and raised after intervals of 7, 14, 21, and 28 days. A comparison of the columns under S-219 in Table 15 reveals that most of the groups of organisms encountered were fairly well represented after 21 days, at least at this season of the year. Accordingly, 21 days was chosen as the standard time for leaving brush boxes in place. Vagaries of weather and river levels did not allow the raising of every box exactly on schedule, but 20 of the boxes placed were allowed to remain near enough to the standard length of time to make them comparable on a time basis. Other boxes were allowed to remain in the river for periods up to 165 days.

These long term boxes were used to determine whether or not organisms would appear which were different from those found in the 21-day boxes. Data from comparable boxes are available from mile S-201.55 (one box left for 21 days, the other for 165 days) and from mile S-165.4 (one box left for 21 days, the other for 139 days). In both these instances the long-term member of the pair contained fewer organisms of the type which cling closely to the substrate (Plecoptera, Ephemeroptera and Trichoptera) than did their 21-day counterparts. This difference can be attributed to the accumulation of slime and silt on the available surfaces. In both these cases the boxes were set where the current was rather weak and such accumulations could take place over long periods of time. Both long-term boxes contained a few burrowing Odonata while the 21-day boxes contained none. The boxes set at mile S-201.55 were in an area heavily enriched by sewage from Augusta, they thus contained appreciable numbers of such forms as oligochaeta, gastropoda and sphaeriid clams. All these groups showed a marked increase in numbers in the 165-day box set at this locality over those in the 21-day box. The presence of many Chironomus riparius in the 165-day box at mile S-201.55 reflects both the pollution and the physical environment at this station. The dipteran populations in each of these pairs of boxes are remarkably similar both quantitatively and qualitatively. Spongilla fragilis was the only organism found in the long-term boxes which was not found in any of the short-term boxes. It occurred in detectable quantities in only two boxes that had been left in the river for 165 and 139 days thus indicating that this form requires a fairly long period for its development.

Since most of the brush boxes were set below the photosynthetic zone, herbivorous animals dependent upon algal growth were relatively scarce. A comparison of the dipteran fauna collected from brush boxes with those collected from algal masses substantiates this assumption. Spaniotoma, a herbivore and the most abundant dipteran in the algal masses, was present in most of the brush boxes, but it was never very common, nor did it ever form a predominant part of the dipteran fauna.

The highest total numbers of organisms were taken from boxes set in the polluted waters below Horse Creek and Butler Creek, both in moderate current, and from boxes set in swift water at miles S-171.7 and S-171.15, although the species compositions from these areas varied considerably. Brush boxes placed in moderate current at the two latter stations did not become as heavily populated as those in swift water at the same place or those in comparable current at polluted stations.

General observations on the distribution of the various groups of organisms in brush box collections follow.

Porifera - Spongilla was found in only two cases, both in boxes that had been in the river over 100 days. It was abundant in the box at S-201.55 below the pollution from Butler Creek.

Turbellaria - Dugesia tigrina was found at widespread locations throughout the river, but it was very abundant only in the boxes from the polluted areas below Horse Creek (S-213.3) and Butler Creek.

Rotatoria - Although many kinds of rotifers were present in the river, the only one readily collected because of its large sizes in brush box sampling, was the sessile, colonial form, Floscularia, sp. It was present at a

TABLE NO. 15 SAVANNAH RIVER STUDIES July 1951-July 1952

SUMMARY - Brush Box Sampling - Numbers of Organisms

Location (River Mi.)	S-223.15	S-219.0					S-215.5
Date Removed	8/24/51	7/30/51	8/6/51	8/13/51	8/20/51	10/16/51	8/27/51
No.of days in place	21	7	14	21	28	21	21
PORIFERA							
Total							
TURBELLARIA							
Total					1		
ROTATORIA							
Total	Pr.*			Pr.	Pr.		Pr.
BRYOZOA							
Total				Pr.			
ANNELIDA:OLIGOCHAETA							
Total	8			2	9		
ANNELIDA:HIRUDINEA							
Total	3						1
ARTHROPODA:CRUSTACEA							
Copepoda							
Ostracoda	145			6	10	43	16
Isopoda							
Amphipoda							
Decapoda						1	
Total CRUSTACEA	145			6	10	44	16
ARTHROPODA:ARACHNIDA							
Total	13						
ARTHROPODA:INSECTA							
Plecoptera							
Ephemeroptera	28	46	50	51	81	58	11
Odonata	34	30	24	26	56	64	11
Neuroptera	1						
Trichoptera	8	12	21	16	25	15	6
Hemiptera							
Coleoptera	7	12	27	11	40	30	
Diptera	109	30	214	216	292	161	125
Total INSECTA	187	130	336	320	494	328	153
MOLLUSCA:GASTROPODA							
Total	8	3	1	2	20	14	43
MOLLUSCA:PELECYPODA							
Total					1		
TOTAL ORGANISMS	365	133	337	332	536	386	61

*/ Pr. = Present

(continued)

TABLE NO. 15 (Continued) SAVANNAH RIVER STUDIES July 1951-July 1952

SUMMARY - Brush Box Sampling - Numbers of Organisms

S-215.5		S-213.3	S-203.3	S-201.55		S-172.0
9/19/51	10/16/51	9/19/51	8/27/51	8/28/51	7/27/52	9/4/51
21	21	21	21	22	165	21
					Pr.	
9	1	238		12	174	
Pr.*	Pr.	Pr.	Pr.	Pr.	Pr.	
					Pr.	Pr.
		62	3	14	399	
3		31		1	16	
79	1	20	3			
79	1	20	3			
3		5		4	3	
7	1	1	13	71	2	39
24	26	66	28	72	30	42
28	6	147	4	182	27	1 30
3	2	6		5	69	40
553	33	1125	318	692	640	50
615	68	1345	363	1022	768	203
159	281	122	1	11	73	
1	1	11		9	74	
870	353	1835	371	1074	1510	204

*/ Pr. = Present

(continued)

TABLE NO. 15 (continued) SAVANNAH RIVER STUDIES July 1951-July 1952

SUMMARY - Brush Box Sampling - Numbers of Organisms

Location (River Mi.)	S-171.7	S-171.6	S-171.52		S-171.15	S-165.4	
Date Removed	10/3/51	12/20/51	10/4/51	10/31/51	9/4/51	9/4/51	7/17/52
No. of days in place	21	37	22	26	21	21	134
PORIFERA							
Total							Pr.
TURBELLARIA							
Total		1		1	4		
ROTATORIA							
Total			Pr.*		Pr.		
BRYOZOA							
Total				Pr.		Pr.	
ANNELIDA:OLIGOCHAETA							
Total					1	1	60
ANNELIDA:HIRUDINEA							
Total					1		
ARTHROPODA:CRUSTACEA							
Copepoda						1	
Ostracoda				1			
Isopoda							
Amphipoda							
Decapoda	1						
Total CRUSTACEA	1			1		1	
ARTHROPODA:ARACHNIDA							
Total	1		5				1
ARTHROPODA:INSECTA							
Plecoptera	87	40	37	49	18	17	
Ephemeroptera	476	47	384	254	527	69	3
Odonata	35		88	16	134	29	4
Neuroptera	11	2	2	2	13	15	5
Trichoptera	3413	54	142	630	4113	2643	61
Hemiptera							
Coleoptera	107	21	516	164	105	50	27
Diptera	720	105	154	372	547	117	71
Total INSECTA	4849	269	1323	1487	5457	2940	171
MOLLUSCA:GASTROPODA							
Total			1	1	1		3
MOLLUSCA:PELECYPODA							
Total							1
TOTAL ORGANISMS	4851	270	1330	1491	5465	2943	237

*] Pr. = Present

TABLE NO. 15 (Continued) SAVANNAH RIVER STUDIES July 1951-July 1952

SUMMARY - Brush Box Sampling - Numbers of Organisms

S-160.75	S-155.25	S-155.2 S-0.0	S-155.17	S-146.4	S-144.7	S-136.6	S-51.0
11/2/51	10/1/51	9/26/51	9/6/51	10/11/51	10/11/51	2/6/52	7/31/52
32	24	20	22	21	21	53	160
1		8		3			
Pr.*							Pr.
Pr.							
6	1	4	2				5
		2		1		2	
		1					
		13		6			
				1			
2						1	
2		14		7		1	
2	2	6		33		8	
45	7		15	1	75	33	7
317	168	1	81	7	514	150	154
31	34	24	38	39	2	2	37
2			7		1	1	2
3437	522	17	1047	8	2252	86	857
104	12	30	109	19	151	69	242
1021	440	120	324	73	2362	34	81
5132	1183	192	1621	147	5357	375	1380
17		1	1	2	9		
9			1				
5171	1186	227	1625	193	5366	386	1386

*/ Pr. = Present

number of stations but was most abundant at polluted water stations.

Bryozoa - Plumatella repens was found at a number of stations, but it appeared to be most abundant at polluted water stations.

Annelida - Oligochaeta and leeches were both found at a number of stations but were most abundant at polluted water stations.

Crustacea - The numbers of small crustaceans, such as copepodes and ostracods, recorded in the accompanying tables are not reliable indications of their relative abundance at various localities. These small organisms were difficult to detect in a sample, and the greatest numbers were taken when the samples were sorted in living condition and the animals could be seen swimming about in the sorting tray. The large free-swimming river shrimps, Macrobrachium ohione and Palaemonetes paludosus, occurred occasionally in the brush boxes.

Arachnida - The small water mites presented the same limitations to estimation of their relative abundance in various localities as did the smaller crustacea.

Insecta - The insects were the most diverse and abundant group obtained in brush box sampling.

The stoneflies (Plecoptera) were found in abundance wherever brush boxes were set in fast water at unpolluted stations.

Mayflies (Ephemeroptera) were present in all of the samples. Burrowing mayflies occurred where boxes were set in soft bottoms or when they accumulated silt deposits. The most abundant genera of mayflies were Stenonema, Caenis, and Tricorythodes. Only one nymph (Hexagenia) was taken from the polluted area below Horse Creek, and one from Steel Creek.

Dragonflies and damselflies (Odonata) were taken in all the boxes except the one from Upper Three Runs. Burrowing dragonflies were present in boxes where accumulating silt provided suitable habitats for them. Climbing nymphs such as those of Argia, Macromia, and Neurocordulia were the most frequently encountered forms.

Larvae of the dobson fly, Corydalis cornutus, (Neuroptera), a carnivorous species, was common in areas of fast water where large numbers of other insects were present.

The caddisflies (Trichoptera) were the most abundant organisms in many of the brush boxes. Macronemum carolina, Hydropsyche spp. and Neureclipsis sp. were extremely abundant in areas with swift current where leaves and detritus accumulated on the box.

Only one water strider (Hemiptera) was taken in brush box sampling, but since these insects live on the surface of the water, its occurrence in this sample was probably accidental.

Three genera of elmid beetles (Coleoptera) which were common in almost all the samples were Ancyronyx, Macronychus, and Stenelmis. Berosus was found only in polluted areas. Other beetles were scattered in distribution.

The bulk of the dipteran populations in the brush boxes was composed of midge larvae (Chironomidae). Ablabesmyia monilis, Limnochironomus modestus and Chironomus riparius were abundant in polluted areas. Endochironomus nigricans was abundant in polluted water, but not in swift current. Polypedilum spp. were abundant in swift water, as were Tanytarsus spp., but the latter forms were absent from polluted areas.

The snipe-fly, Atherix variegata, and black-fly, Simulium sp. were both found in Upper Three Runs and in swift-water areas below that point. Ceratopogonids were found in scattered localities, but never in large numbers.

Mollusca: Both pulmonate and gilled snails were most abundant in polluted areas. Fingernail clams, Sphaeriidae, occurred when bottom deposits accumulated in the brush boxes. They were also most abundant in polluted areas.

Nekton

The four principal objectives of the investigation of fish populations in the river were to determine: (a) the species composition of the population; (b) the extent of utilization by man; (c) some important aspects of the biology of the principal species (particularly catfish); and (d) fish movement.

Three methods were used to obtain information applicable to the above objectives; (a) the observation of commercial and sport fishing, (b) the use of seines, and nets, for sampling; and (c) the use of rotenone to obtain samples.

Each of these methods yielded different information in the study of fish populations and will be discussed separately.

COMMERCIAL AND SPORT FISHING

Commercial Fishing

Two types of commercial fishing were observed in the fresh-water areas of the Savannah River; a basket fishery, principally for channel catfish, and a gill net fishery for American shad and other anadromous

herrings. Contacts with the fishermen engaged in these activities were entirely fortuitous due to the scattered and unsystematic nature of the commercial fishing on the river. Observations of sport fishing were limited to chance interviews with sport fishermen encountered during the course of the study.

Basket Fishing for Catfish

The basket fishery for catfish is the most intensive commercial fishery in the fresh-water areas of the river. Three fishermen were observed operating regularly in the area from Augusta (S-216.0) to Porter's Landing (S-74.3), and others were observed operating in the area around Ebenezer Landing (S-48.1) and Lockner Creek (S-46.33). None of them was entirely dependent upon commercial fishing for a livelihood. The wire baskets used in this fishery are highly selective for catfish. The principal and most valuable species taken was the southern channel catfish (Ictalurus lacustris punctatus). The two other catfish appearing regularly in catches were the white catfish (Ictalurus catus) and the flat bullhead (Ameiurus platycephalus). These were of little commercial value. A number of other species occurred occasionally in the catch.

Selected fish from several catches were examined in July and August 1951, and twelve total catches were examined from August 1951 to May 1952. In examination of these catches all fish were identified and measured. The sex of some mature individuals was determined and pectoral spines were removed from the catfish. */

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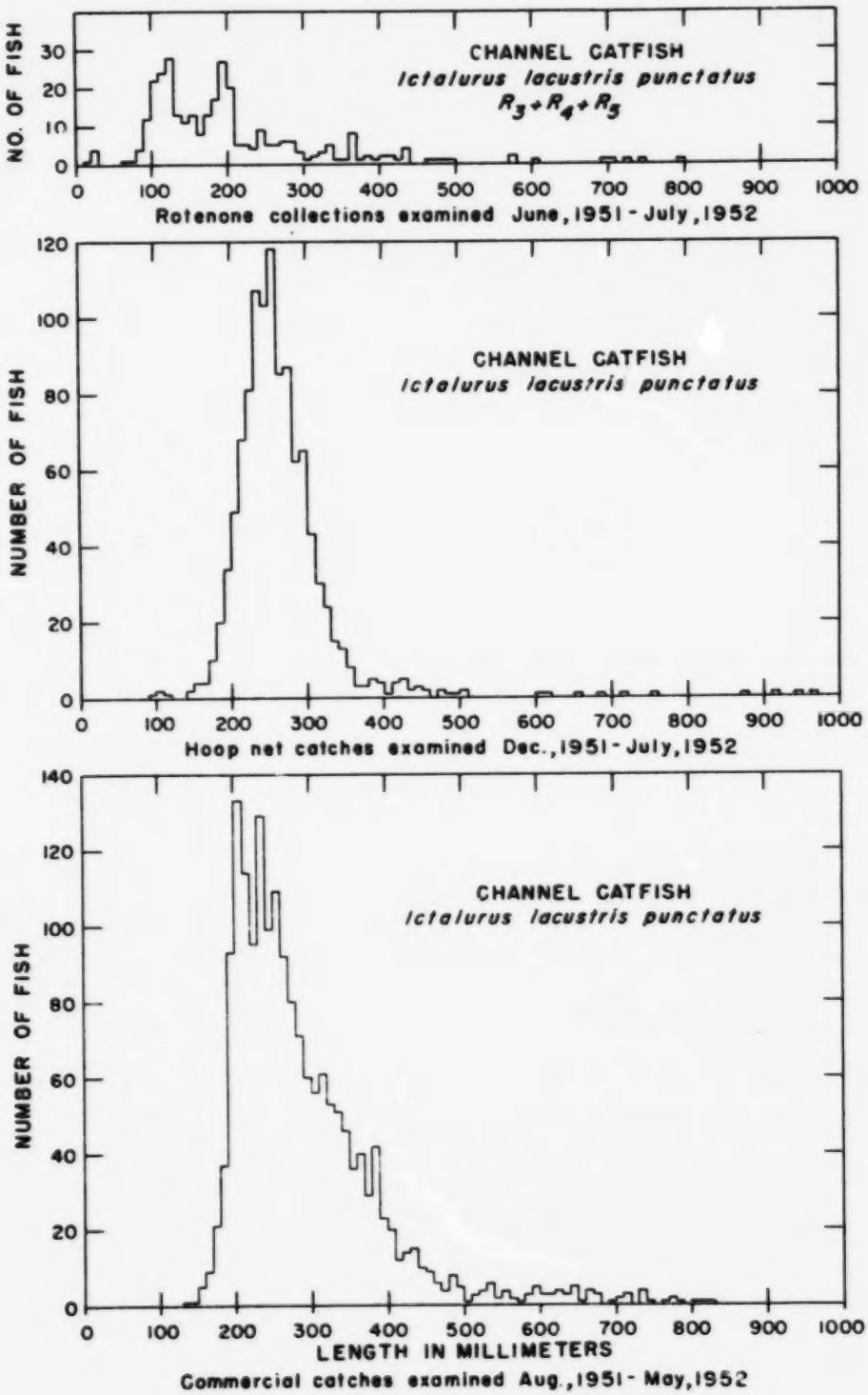
*/ These spines are being retained at the Department of Biology, University of Georgia, for age and growth rate studies.

Table 16 shows a summary of these catches. Channel catfish comprised 84.3% of the catch, white catfish 10.6%, flat bullheads 3.6%, and other species 1.5%. The length-frequency distributions of catfish from commercial catches are shown in Figures 28, 29, and 30.

The size of the catches was extremely variable. The same fisherman reported catches of as much as 700 and as little as 50 pounds per week. The fishery was somewhat seasonal; fishermen reported fishing to be best in the spring and the fall and poor during the summer months. The commercial value of these catches to the fisherman averaged about 40 cents per pound live weight. Most of the fish were sold to eating establishments located near the river.

Shad Fishing

The American shad and two or three other anadromous species of herring ascend the river to spawn in late winter and spring and are subjected to a limited local fishery. In 1952 the operation of this fishery was observed directly by interviewing fishermen and accompanying them on the rounds of their nets whenever possible. The large meshed (5 - 6" stretched) gill nets used in this fishery are either placed at stationary sets in eddy waters, or are drifted down straight stretches of river channel. Fishing for the two commercially valuable species, American shad (Alosa sapidissima) and hickory shad (Pomolobus mediocris), began early in January on the lower river (around mile S-48), and about a month later at mile S-146. Fishing continued into the month of April when longnose gar (Lepisosteus osseus) and bowfin (Amia calva) became so numerous in the catches as to interfere with the operation of the nets and thus



LENGTH - FREQUENCY DISTRIBUTION

FIG. 28

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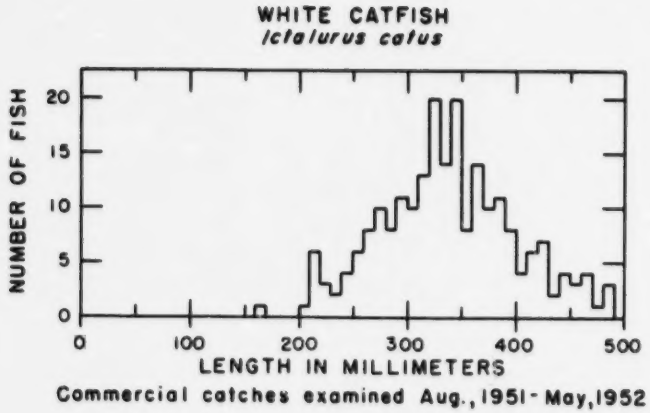
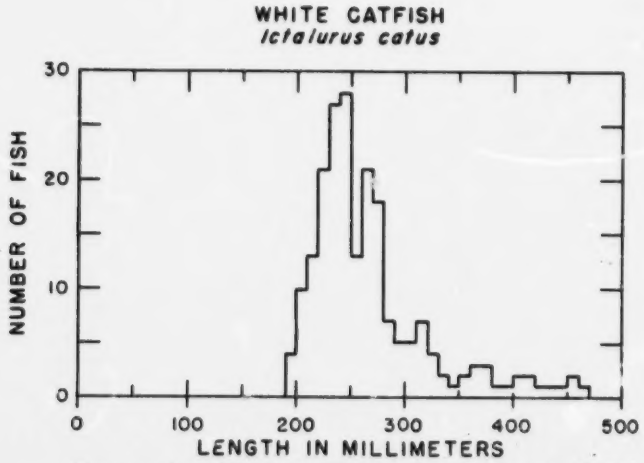


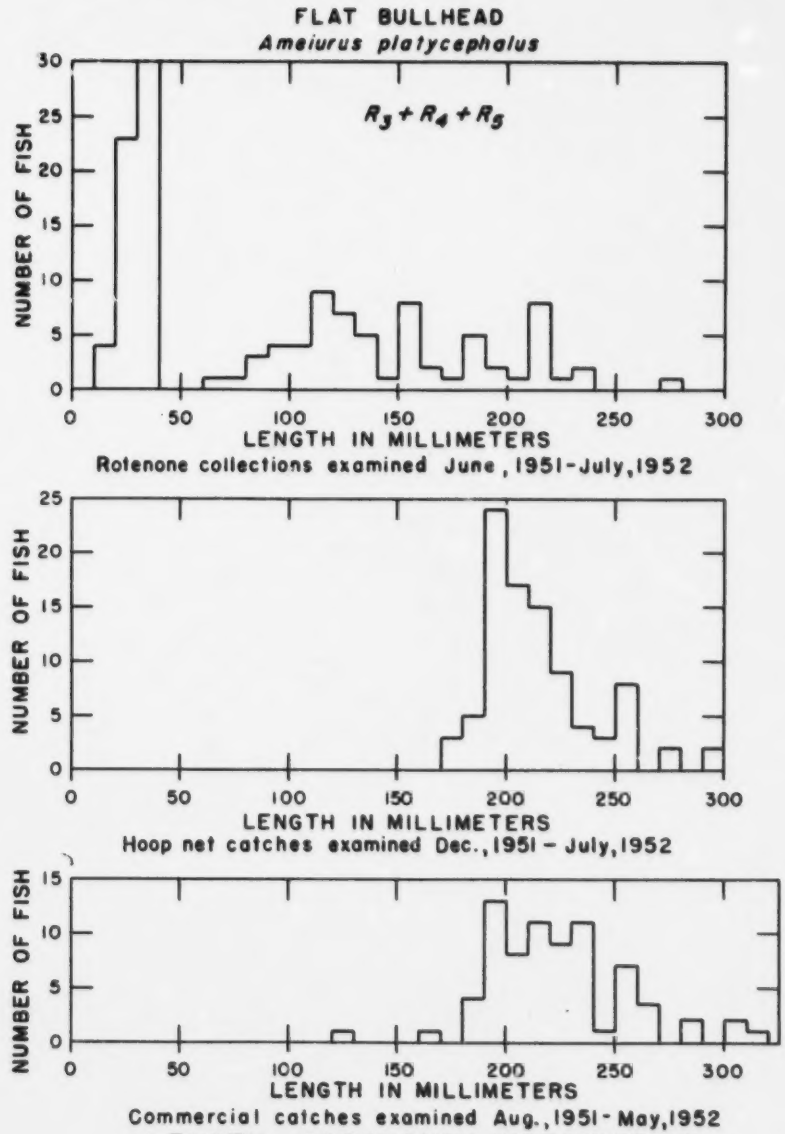
Commercial catches examined Aug., 1951 - May, 1952



Hoop net catches examined Dec., 1951 - July, 1952

LENGTH — FREQUENCY DISTRIBUTION

FIG. 29



Rotenone collections examined June, 1951 - July, 1952

Hoop net catches examined Dec., 1951 - July, 1952

Commercial catches examined Aug., 1951 - May, 1952

LENGTH — FREQUENCY DISTRIBUTION

FIG. 30

render fishing unprofitable. After mid-April, a large percentage of the caught shad were spent and worthless. The last spent shad observed in the river was seen floating at mile S-155.3 on June 16.

Seven gill net catches, in which 100 American shad and 19 hickory shad were present, were examined. The length, weight, and sex were recorded for each fish. A scale sample was removed from each fish for age determination. */

Table 17 summarizes the catches examined. Considering the shad only, the American shad comprised 84% of the catch and the hickory shad 16%. These figures are not considered to represent the relative abundance of the two species in the river since the large meshed nets of the fishery are obviously selective for the larger species. This is evidenced by the fact that many more females than males of both species were caught, the females averaging considerably larger than the males. The length-frequency distributions of the shad from these catches are shown on Figure 31.

At least two other species of anadromous clupeid fishes ascend the Savannah River to spawn. The glut herring (Pomolobus aestivalis), a small but abundant species, is of no commercial value but is often taken in small-meshed gill nets to be used as cut bait. Fishermen report that another clupeid (probably the alewife, Pomolobus pseudoharengus) preceded the shad run, but specimens of this fish were not obtained so its identity remains in doubt. The striped bass (Roccus

*/ Scale samples have been transmitted to the United States Fish and Wildlife Service for use in their study of shad in the southeastern States.

saxtilis) is occasionally caught in the shad nets, as is the sturgeon (probably Acipenser oxyrhynchus).

Fishermen operating in the lower river rated shad fishing as fairly good in 1952 when compared with that of the previous few years. Many of the fish caught in this area are sold in Savannah, Springfield and neighboring towns. The American shad were sold for from $1.25 to $2.00 each, while the hickory shad usually brought about $.75 each. This type of fishing seemed to be engaged in as much for sport as for profit by some of the fishermen interviewed.

Sport Fishing

Observations of sport fishing on the Savannah River indicate that hook-and-line fishing may be classified as follows:

1. Bank line, trot line and cane pole fishing for channel catfish.
2. Cane pole fishing and casting for largemouth black bass, crappie, and the various species of pan-sized sunfish.
3. Casting for striped bass.

The value and importance of sport fishing on any large stream is difficult to assess. Very few sport fishermen were encountered on the river proper and sport fishing seemed to be much more intensive on some of the tributary streams and flood plain lakes than on the river itself. While sport fishing on the river itself was apparently of negligible importance at the time these studies were made, it might well increase considerably if the operation of Clark Hill Dam causes the river to become clearer. At the same time increasing human population in the

Augusta area will no doubt result in greater use of the river for sport fishing.

SEINE AND NET SAMPLING

Hoop Netting

Hoop nets with a diameter of five feet and mesh size of approximately one inch were used to collect fishes for radiological background determinations and to obtain additional information on the fish populations of the river. The nets were baited with cottonseed-meal cake and usually set in fast water. This type of sampling was conducted at intervals from December 1951 into July 1952, over the stretch of river from S-172.5 to S-140.1. A total of 117 net hauls were made during this period. The results of this sampling are shown on Table 18.

Hoop nets operate in a manner similar to that of the wire baskets used by commercial fishermen and they were set in much the same situations; however, they appeared to be somewhat less selective for catfish. Catfish comprised 85.6% of the commercial catches examined and 77.8% of the hoop net catches. Considering only the three common species of catfish, these differences in the composition of the catch are shown in Table 19.

TABLE 16

SAVANNAH RIVER STUDIES
BASKET FISHERY
Commercial Catches Examined

Date	Location River Miles	Numbers of Fish: Channel Catfish	White Catfish	Flat Bullhead	Others**/	Total No.	Total Weight Pounds
8/31/51	S-91.7 - S-74.3	309	20	11		340	167
9/7/51	" "	198	15	3		216	100
9/14/51	" "	117	3	6	13	139	78
9/28/51*/	Vicinity S-122	133	58	21		212	150
10/5/51	S-152.2 -S-146.4	271	65	8		344	284
10/13/51	" "	62	12	3		77	-
10/23/51	" "	42	2	4		48	-
10/26/51	" "	124	9		5	138	-
10/29/51	" "	235	11		3	249	-
11/22/51	" "	91	20	4	1	116	141
11/30/51	" "	31	7	8	7	53	-
5/12/52	" "	152		7	2	101	-
TOTAL NO.		1,765	222	75	31	2,093	
% of Total Catch		84.3	10.6	3.6	1.5		
Average Length mm		294	340	226			

*/ Figures represent approximately 75% of total catch

**/ American Eel, Red Horse Suckers, Carp, Brown Bullhead, White Crappie, Redbelly Sunfish, Striped Bass.

TABLE 17

SAVANNAH RIVER STUDIES
SHAD FISHERY
Commercial Catches Examined

Date	Location River Miles	Numbers of Fish: American Shad *Alosa sapidissima* male	American Shad *Alosa sapidissima* female	Hickory Shad *Pomolobus mediocris* male	Hickory Shad *Pomolobus mediocris* female	Total No.
2/22/52	S-44.4 - S-48.1	4	9		7	20
3/7/52	S-44.4 - S-46.4	12	14	1		27
3/7/52	S-36.5	3	7		9	19
3/12/52	S-46.4	1	10			11
3/12/52	S-36.5	13	7		1	21
3/21/52	S-46.4	1	13			14
4/10/52	S-146.4		6	1		7
TOTAL NO.		34	66	2	17	119
Average Total L. in mm		480	540	370	446	
Average Weight in gm		1,272	2,010	--	1,034	

TABLE 18

SAVANNAH RIVER STUDIES
COMPOSITION OF HOOP NET CATCHES
S-172.5 -- S-140.1
December 3, 1951 - July 12, 1952

Species	Number
Lepisosteus osseus osseus	18
Alosa sapidissima	1
Carpiodes n sp.	9
Moxostoma spp.	34
Minytrema melanops	22
Cyprinus carpio	6
Ictalurus lacustris punctatus	1,160
Ictalurus catus	209
Ameiurus platycephalus	124
Perca flavescens	1
Pomoxis annularis	5
Pomoxis nigro-maculatus	10
Lepomis auritus	1
Lepomis macrochirus purpurescens	1
Roccus saxatilis	6
TOTAL	1,607
Number of Net Hauls	117

TABLE 19

	Commercial Fishing			Hoop Netting		
	% by Number	Average Lengths mm	Modal Lengths mm	% by Number	Average Lengths mm	Modal Lengths mm
Channel Catfish	85.6	294	210	77.8	270	260
White Catfish	10.8	340	340	14.0	272	250
Flat Bullhead	3.7	226	200	8.3	219	200

Length-frequency distributions of these fish are shown in Figures 28, 29, and 30. The differences between percentage composition, average lengths, and modal lengths of fish from commercial and hoop net catches are probably due to differences in the size selectivity of the gear and seasons of greatest fishing effort. In many cases very small fish, game fish, and fish of undesirable species, were discarded from commercial catches before they could be examined. This fact alone could account for most of the observed differences in the catch.

Two striking abnormalities were noticed among the catfish examined. A few white catfish in both the hoop net and commercial catches were observed to be in an extremely emaciated condition. A number of these fish were autopsied but no obvious cause for their condition was discovered. Occasionally channel catfish were caught in which extensive areas of the body or head were covered with bloody mucus. Although these areas appeared to be tumorous or ulcerous, close inspection revealed that the skin beneath them was bloody but unbroken. Neither of these abnormalities (extreme emaciation and mucus accumulation) occurred in large

numbers of fish and both remain unexplained.

Gill Netting

Opportunities for setting small-meshed gill nets were limited. The accumulation of drifting debris on nets set in current would cause them to be swept away a few hours after they were set. Gill netting was, therefore, limited to the backwater at Little Hell Landing (S-146.4). Experimental gill nets set in the winter and spring of 1952 took small numbers of American shad, redhorse suckers, longnose gar, black bass, and other fish, but they yielded little information on the composition of fish populations.

Seining

Swift water and the presence of underwater obstacles such as stumps and snags made seining difficult and seine collections were generally limited to shallow areas around sand bars with small seines (10' - 25' long). Seine hauls attempted with a 100' seine and a large crew proved unprofitable because of the difficulties imposed by the current and snags. Even small seines could not be operated effectively by less than three men. Thus, a systematic program of seine sampling was not attempted.

The seining that was done yielded additional information only on the occurrence of minnows and other small fish. The billfish (*Strongylura marina*) was the only fish that was taken by no method other than seining. The most common fish taken in the seine collections were silvery minnows (*Hybognathus nuchalis regius*) and the spottail shiner (*Notropis hudsonius saludarus*).

ROTENONE SAMPLING

Five fish collections were made in 1952 using rotenone in the form of a 5% emulsifiable solution; two were from sloughs, and three from the river proper. The quantity of rotenone used in sloughs was determined from a rough calculation of the total volume of water in these areas. The poison was then distributed by means of a bucket pump and hose, and with buckets. Vertical mixing was accomplished by running outboard motors over the areas where the poison had been distributed. It was more difficult to make satisfactory collections from the river proper. In each case five gallons of rotenone were distributed in the form of a vertical wall of high concentration which drifted downstream over the area to be poisoned. Vertical distribution was effected in deep water (3 feet or more) by pumping the mixture through a hose which was raised and lowered as the boat moved across the stream. Fluorescein dye was mixed with the rotenone so that the movement and distribution of the poison could be traced visually. Invariably the wall of poison drifted downstream diagonally due to the more rapid flow of water toward the center of the river. The size of the area which was effectively sampled could not be estimated accurately in most instances because of the variability with which the eddy currents dispersed the rotenone. All affected fish that could be reached were collected. The area that was poisoned effectively varied for different species of fish depending upon their sensitivity to rotenone. Thus, a larger area was poisoned to obtain sensitive species, such as the gizzard shad, and a lesser area for more hardy species, such as the flat bullhead. A greater percentage

of the fish poisoned in still water were retrieved than in flowing water, since the current undoubtedly removed many of the dying fish from these areas before they could be collected.

One rotenone collection was made at each of the following stations:

1 - 5/14/52, S-133.9: A backwater behind Ring Jaw Point on the South Carolina side, about one acre in extent, which was broadly open to the river downstream. There were flooded areas of trees and brush along the edges of the backwater and at the upper end. The average depth was approximately 3-1/2 feet and the maximum depth about 8 feet. There was no current.

2 - 5/14/52, S-133.8: A long narrow slough on the South Carolina side less than 1/2 acre in extent which was overgrown with cypress and had a very narrow, shallow channel opening to the river. The average depth was approximately 2-1/2 feet and the maximum depth about 5 feet. There was no current.

3 - 6/30/52, S-148.8: Catfish Hole, where the river made a sharp bend toward the Georgia side and a moderate current flowed against the bank. There was a submerged sand bar at the upper end of this bend between the hole and the main channel of the river. The average depth of the hole was about 15 feet. The current of the river proper at this point was swift. The maximum depth was about 28 feet. The rotenone was placed between the sand bar and the Georgia shore. The current formed a large eddy at the lower end of the bend which sent a back-current through the hole, providing good recirculation of the poisoned water. An area of about 3/4 of an acre was sampled.

4 - 7/1/52, S-171.6 - 171.1: A cut-off on the Georgia side of the river across from the mouth of Upper Three Runs. The mouth of the cut-off was narrow with a fast current which became moderate as the channel widened to about 100 feet. The average depth was about 3 feet and the maximum depth about 6 feet. The rotenone was applied at the upper end of the cut-off and was effective throughout its entire length and for a short distance downstream in the river. The area thus poisoned was approximately 6 acres.

5 - 7/3/52 S-130.0: Three rows of pilings extended about 125 feet into the river from the Georgia side. A sandy bottom sloped gradually from the shore to a maximum depth of 10 feet at the outer edge of the pilings. The current increased from zero along the shore to rapid at the ends of the pilings. The rotenone was placed at the upper end of the middle pilings and was effective over an area of about 1-1/2 acres.

Poisoning with rotenone is one of the least selective methods of sampling fish populations. Such sampling presented the most reliable information on the composition of the fish populations, as it revealed the presence of species not collected by other methods, and yielded additional information on many other species. The results of rotenone sampling are shown in Table 21.

Samples 1 and 2, taken in sloughs, showed differences in species composition from those taken in areas more representative of the river proper. Sample 5 was obtained at a station which had both sluggish and rapid water areas, and it contained species characteristic of each of these habitats. The sloughs contained more longnose gar (Lepisosteus

osseus), carp (Cyprinus carpio), chain pickerel (Esox niger), and redfin pickerel (Esox americanus) than did the river. White catfish (Ictalurus catus) and flat bullheads (Ameiurus platycephalus) were absent in these still water areas, and channel catfish (Ictalurus lacustris punctatus) were scarce. The largest numbers of these three catfish were taken in samples 3 and 4 from areas of flowing water. The tadpole madtom (Schilbeodes mollis) was found in the still water areas, while another madtom (Schilbeodes leptacanthus) was taken at the fast water stations. Barratt's darter (Hololepis barratti), which prefers quiet water and bottom materials rich in organic matter, was found in the collections from sloughs, while the Johnny darter (Boleosoma nigrum) was found at the three flowing water stations. The American eel (Anguilla rostrata) was common in the sloughs and at S-130.0, where some still water was present. There were also differences in the species composition of the minnow populations in the two types of habitat. Golden shiners (Notemigonus chrysoleucas bosci) preferred the still water areas, as did the shiner (Notropis maculatus). The spottail shiner (Notropis hudsonius saludanus) was scarce in the sloughs and abundant at the other stations.

AGE AND GROWTH DETERMINATIONS

Length-frequency distributions were constructed for those species of which adequate numbers of individuals were obtained. From these distributions some conclusions regarding the age-composition of the population can be drawn. Fish from samples 1 and 2 taken in May showed similar length-frequency distributions and could be grouped together. The same

was true for the fish taken in late June and early July. There were noticeable length differences between the fish taken in the spring (Samples 1 and 2) and those taken in the early summer (Samples 3, 4, and 5), and except in the case of bluegills, the length-frequency distributions of fish taken at these two periods were kept separate.

The histograms illustrating the length-frequency distribution of the commercial catches and the hoop net catches cannot be compared directly with that of the rotenone samples because of the size-selectivity of these operations and because these histograms represent fish taken throughout the year rather than at one season. However, these figures do indicate that the bulk of the commercial catfish fishery is composed of fish two years old or older.

Channel catfish - A sufficient number of channel catfish was taken in Samples 3, 4, and 5 to construct a length-frequency distribution histogram. (Figure 28). A small but well-defined group consisting of five young-of-the-year fish with an average length of 26 mm. was present. Because of the very small size of the individuals, this age-group was very inadequately sampled. The remaining fish form a distinctly bimodal curve with modes at 130 and 200 mm., strongly suggesting that these represent one- and two-year-old fish respectively. The scattered distribution of the larger fish offers no clue to the sizes attained by the older age groups. This age distribution remains to be confirmed by examination of sections of the pectoral spines of these fish.

Flat bullhead - The length-frequency distribution histogram (Figure 30) of the flat bullheads from Samples 3, 4, and 5 shows the presence of

a sizeable group of young-of-the-year fish with an average length of 34 mm. The year-classes of older fish are not clearly delineated, but the mode at 120 mm. obviously represents one-year-old fish. This reveals that the commercial catch of this species is composed largely of fish at least two years old.

Silvery-Minnow - Sufficient numbers of this species were taken in all rotenone samples to determine the growth rate from May until July. (Figure 32). The young-of-the-year fish taken in May ranged in size from 20 to 33 mm. By the end of June and beginning of July these fish had reached an average length of 39 mm. The year-old fish collected in May had an average length of 71 mm. The one fish 110 mm. long was probably two years old. By the time the second series of samples had been taken, the lengths of the year old fish had increased to an average length of 80 mm.

Spottail shiner - The distribution of these shiners from Samples 3, 4, and 5 (Figure 33) shows two definite year-classes and the possibility of a third. The young-of-the-year fish averaged 35 mm. in length and the year-old or older fish averaged 86 mm. Of these, the small numbers of larger fish may represent two-year-olds. */

Pirate perch - Few adults of this species were taken in the rotenone collections. The growth rate of the young-of-the-year fish that were collected from May to July was determined. (Figure 34). In

*/ Only about one-half of the juvenile fish of the silvery minnow and the spottail shiner collected were measured, thus, the actual proportions of young-of-the-year fish to year-old fish were about twice as great as they appear in the histograms.

Samples 1 and 2 this year-class averaged 27 mm. If 50 mm. is considered as the upper limit of this year-class in Samples 3, 4, and 5, its average size in July was 37 mm., an average length increase of 10 mm. during this period.

Bluegill - No conclusions could be drawn regarding the age-composition or growth rate of the bluegill from the information collected in rotenone sampling, because of the extended spawning period of this species which lasts throughout the summer. The length-frequency distribution histogram of the species (Figure 35), however, does show the general size-composition of the population.

FISH MOVEMENT STUDIES

As discussed in the section dealing with radiological studies on fishes, it is the individual fish and the amount of radioactivity that it can acquire that is of the greatest interest from the standpoint of environmental health. If a radiological health hazard should develop in the Savannah River, it would be necessary to have information on the extent of movement of individual fish from areas where high activity might be acquired into other areas. Therefore, a marking experiment was begun on May 8, 1952, and continued through July 12, 1952, to obtain information on the extent of movement of catfish in the vicinity of the Savannah River Plant of the Atomic Energy Commission.

Fish were taken in hoop nets from three areas and were marked by clipping off their pelvic fins. Fish from the upper station (S-155.35 - S-155.15) were marked by removing the right pelvic fin; those from the middle station (S-149.7 - S-149.3) by removing both pelvic fins, and those

from the lower station (S-146.3 - S-146.1) by removing the left pelvic fin. Thus, it could be determined at which area a recaptured fish had been marked. The results of this marking experiment are shown in Table 20. In addition to recaptures taken in the course of the marking experiment, one channel catfish with a double pelvic clip was taken in a rotenone sample at Catfish Hole (S-148.8), less than one mile from the point where it was first captured.

Channel catfish were found to move both up and downstream as far as 5.6 miles. A relatively small number of white catfish were marked, and only three recaptured. They were found upstream from the point of marking. Flat bullheads gave the highest proportion of recaptures of fish marked. These were all taken at the stations where they were first captured, indicating that this species is more sedentary than the other two species of catfish.

The relatively small numbers of recaptures taken during the course of fish movement studies and from the rotenone collections made within the study area indicated that a large population of catfish was present. The study, although conducted for a limited period of time and within a relatively short stretch of river, showed that channel and white catfish did move distances of several miles.*/

ANNOTATED LIST OF FRESH WATER FISHES

The following is an annotated list of fishes known to occur in

*/ A more detailed study of catfish movements in the river is being continued by Mr. Robert Humphries, a graduate student at the University of Georgia, on an A.E.C. grant.

TABLE 20 - SAVANNAH RIVER STUDIES
RESULTS OF CATFISH MARKING EXPERIMENT
May 8 - July 12, 1952

Location (River Miles)	No. of hauls	Channel Catfish					White Catfish				Flat Bullhead				
		Total No. caught*	Total No. marked	Recaptures R	D	L	Total No. caught*	Total No. marked	Recaptures R	D	Total No. caught*	Total No. marked	Recaptures R	D	L
S-155.35-S-155.15 Right pelvic clip (R)	32	226	213	11			15	15			12	11	1		
S-1[illegible] S-14[illegible] Double pelvic clip (D)	34	321	299	3	12	1	83	77	1	2	53	41		12	
S-146.3-S-1[illegible]6.1 Left pelvic clip (L)	28	425	375		2	45	104	100			42	37			5
Total commercial catches from S-155.6 to S-146.3	19	559		3	2		8				16				
TOTAL	113	1531	887	17	16	46	210	192	1	2	123	89	1	12	5

* Including recaptures

TABLE 21

SAVANNAH RIVER STUDIES
Results of Rotenone Sampling

Sample No.	1	2	3	4	5
Sampling Point	S-133.9	S-138.8	S-148.8	S-171.6 171.1	S-180.0
Date	5/14/52	5/14/52	6/30/52	7/1/52	7/3/52
Lepisosteus osseus oculatus	7	8	1		2
Amia calva	2	1		1	1
Pomolobus sapidissima)					1
Pomolobus mediocris)	2				
Dorosoma cepedianum	2			3	3
Anguilla rostrata	14	26			16
Carpiodes n. sp.				7	
Moxostoma crassilabre)		)	)	8	
Moxostoma collapsum)	1	)	1)		
Moxostoma papillosum)		)		1	
Minytrema melanops	6			3	2
Erimyzon sucetta sucetta	1				1
Cyprinus carpio	13			1	
Hybognathus nuchalis regius	24 + fry	409 + fry	149	415	384
Notropis callisema	94				1
Notropis leedsi			31	32	40
Notropis hudsonius salidanus	6		84	161	205
Notropis maculatus	44	54			4
Notropis petersoni	10	12		10	17
Notemigonus chrysoleucas bosci	12	1			1
Opsopoeodus emiliae emiliae	144	10		8	2
Ictalurus lacustris punctatus	12		103	190	21
Ictalurus catus			4	4	2
Ameiurus platycephalus			36	70	17
Ameiurus nebulosus marmoratus	4				7
Schilbeodes leptacanthus			1	8	
Schilbeodes mollis	2	1			

TABLE 21 (continued)
SAVANNAH RIVER STUDIES
Results of Rotenone Sampling

Sample No.	1	2	3	4	5
Sampling Point	S-133.9	S-133.8	S-148.8	S-171.6-171.1	S-130.0
Date	5/14/52	5/14/52	6/30/52	7/1/52	7/3/52
Chologaster cornutus		3			
Esox americanus	7	10	1		
Esox niger	8	6			
Gambusia affinis holbrooki	3		9		
Aphredoderus sayanus	10	42	65	42	27
Trinectes maculatus		2			
Labidesthes sicculus	7	3		1	1
Boleosoma nigrum			1	1	1
Ololepis barratti	1	6			
Micropterus salmoides	7	2	3	8	16
Enneacanthus gloriosus	2	3			
Centrarchus macropterus	5			1	
Chaenobryttus coronarius	28	20	9	1	57
Lepomis auritus	17	3	1	3	27
Lepomis macrochirus purpurescens	76	35	48	30	95
Lepomis marginatus	4	3	2	1	8
Lepomis microlophus	1	2	4	7	
Pomoxis annularis	31	2	3	8	32
Pomoxis nigro-maculatus	35	1	1	15	9
Elassoma zonatum		5			

the fresh waters of the Savannah River:

1. Atlantic Sturgeon - Acipenser oxyrhynchus. Apparently a few sturgeon still ascend the river to spawn. Fishermen reported catching small individuals in gill nets at the mouth of the Lochner Creek (S-46.4) in 1952. A specimen 6' long and weighing 95 lbs. is reported to have been taken at this locality in 1951.

2. Longnose Gar - Lepisosteus osseus osseus. This species of gar appears to be abundant and ubiquitous in the river. Although it is often caught in gill nets, it is rarely used as food and is generally considered a nuisance.

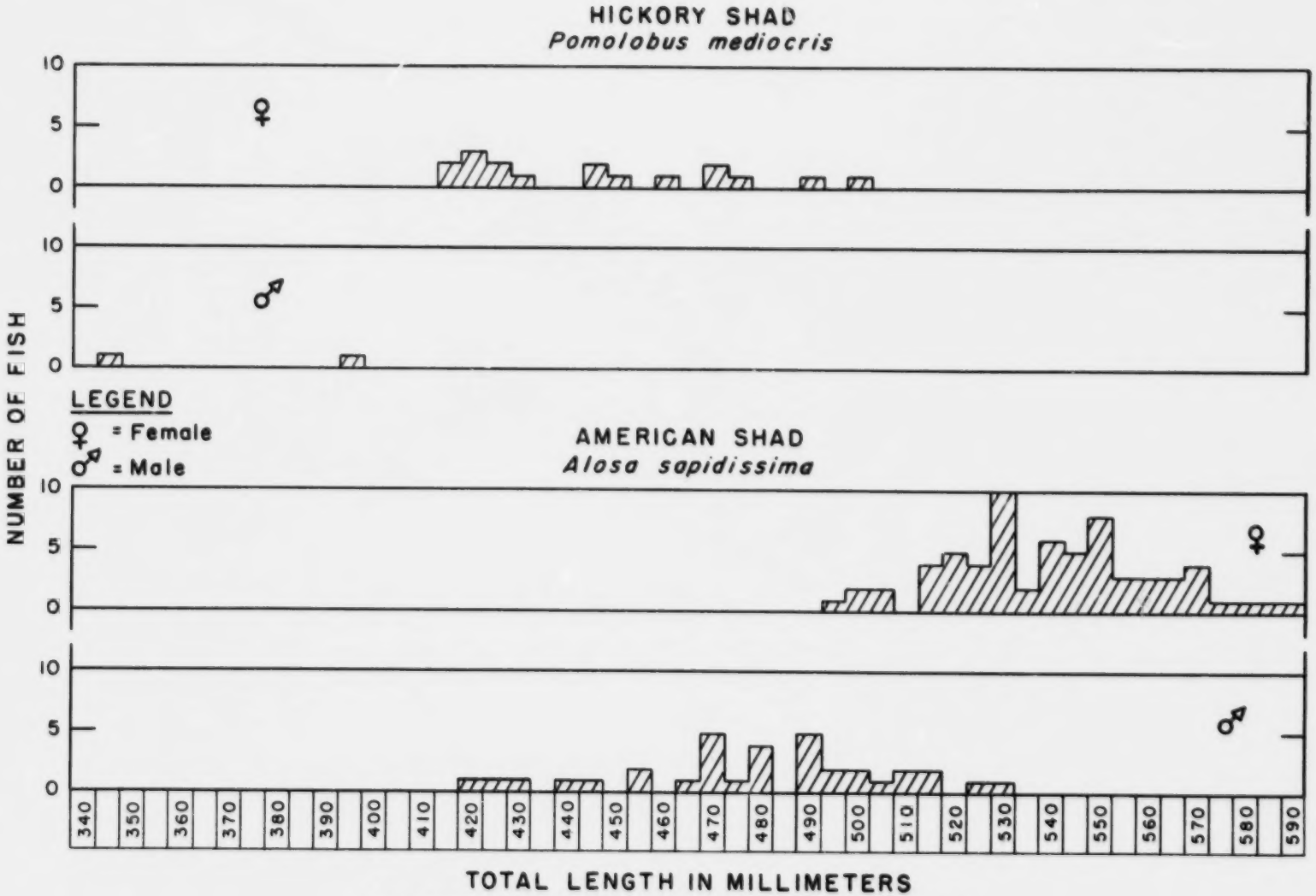
3. Florida Gar - Lepisosteus platyrhynchus. A single dried specimen obtained from a fisherman at Lochner Creek has been identified as this species. It is apparently very scarce in the river.

4. Bowfin - Amia calva. This species is abundant in quiet backwaters and frequently taken in gill nets. It is seldom used for food.

5. American shad - Alosa sapidissima. The American shad ascends the river in fair numbers to spawn from January through April. Although spawning was not observed, it probably occurs in the river at the mouths of tributary streams. This commercially valuable fish is the object of a limited local fishery in the lower river.

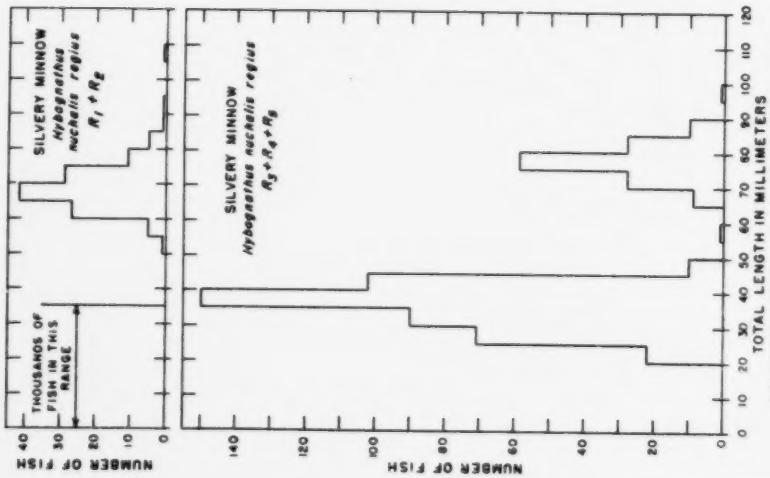
6. Hickory Shad - Pomolobus mediocris. The habits of the hickory shad are similar to those of the American shad and it is regularly caught with the former species. Because of its smaller size it is taken less readily in gill nets than the more valuable American shad.

7. Glut Herring - Pomolobus aestivalis. This species ascends

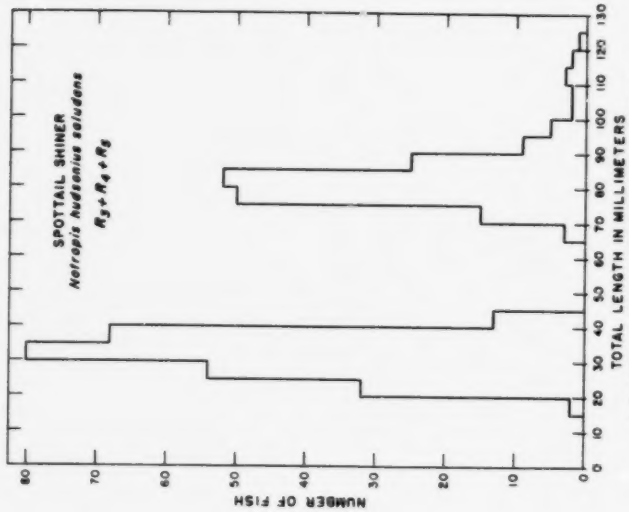


LENGTH—FREQUENCY DISTRIBUTION
From commercial shad catches examined Feb.-April, 1952

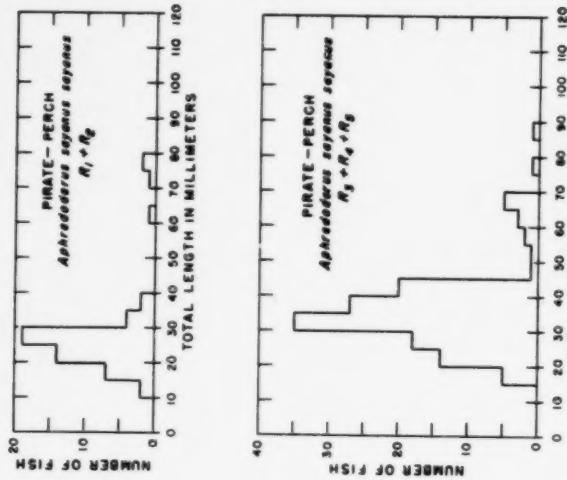
FIG. 31



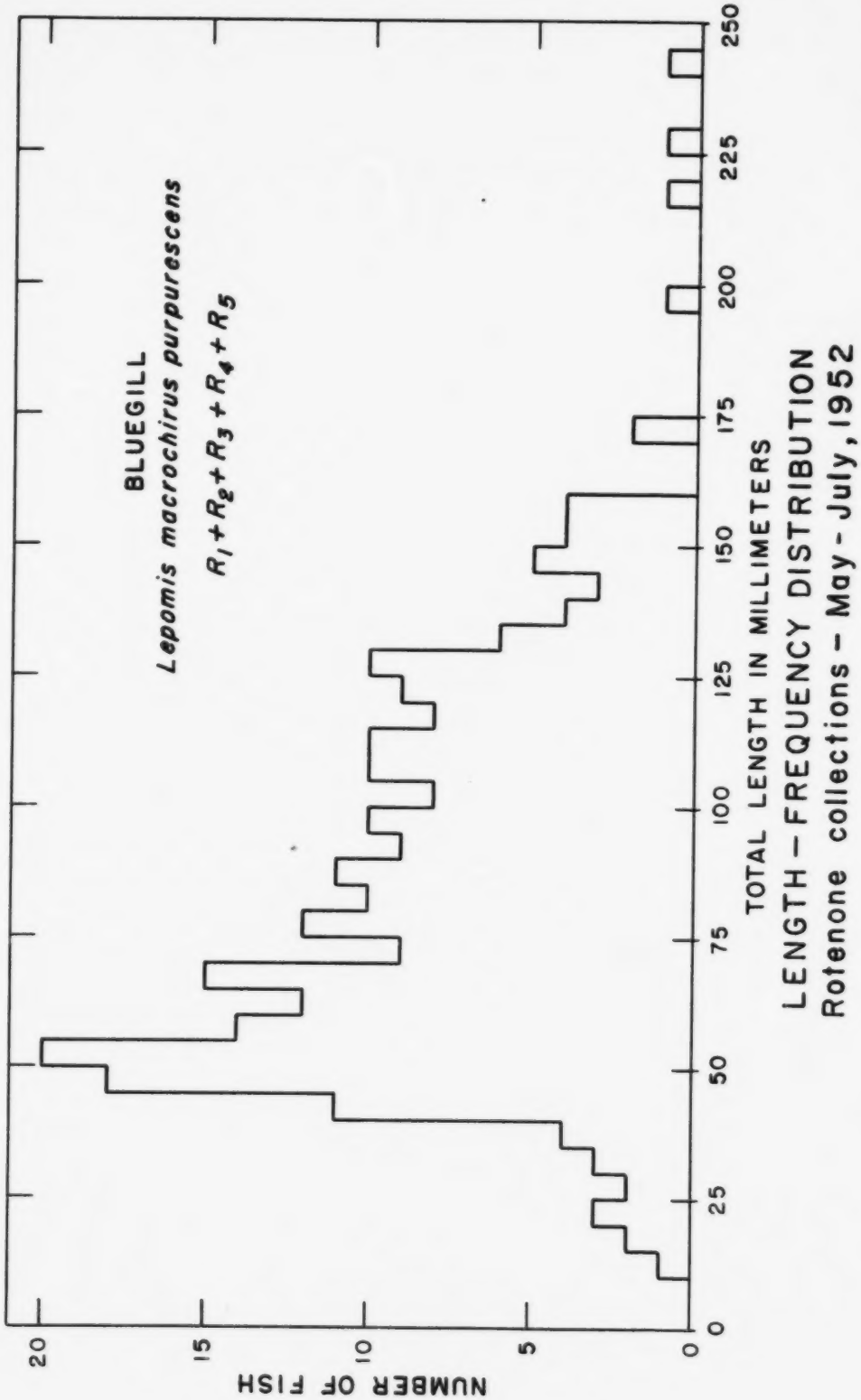
LENGTH – FREQUENCY DISTRIBUTION
Rotenone collections – May 14, June 30, July 1 & 3, 1952
FIG. 32



LENGTH – FREQUENCY DISTRIBUTION
FIG. 33



LENGTH – FREQUENCY DISTRIBUTION
FIG. 34



LENGTH – FREQUENCY DISTRIBUTION
Rotenone collections – May - July, 1952

FIG. 35

the river in considerable numbers in March and April. Being even smaller than the hickory shad, however, it may be taken only in smaller-meshed nets. When caught it is used only as cut bait and has no commercial value.

8. Alewife - Pomolobus pseudoharengus. Fishermen have reported a clupeid fish different from the three preceding species which ascends the river before the shad run begins. It is assumed that this is the alewife, although no specimens were collected.

9. Gizzard Shad - Dorosoma cepedianum. This shad appears to be abundant throughout the river. It has no economic value.

10. American Eel - Anguilla rostrata. The eel is a fairly abundant fish. It is sometimes taken in catfish baskets and on set lines. It is used as food and as cut bait for catfish lines.

11. Carpsucker - Carpiodes n. sp. This apparently new species of carpsucker was taken occasionally by a gill net fisherman at Little Hell Landing (S-146.4). Seven adult specimens were collected in a rotenone sample at S-171.6. Young fish, presumably of this species, were seined from sandbars in this section of the river.

12. Redhorse Sucker - Moxostoma crassilabre. */

13. Redhorse Sucker - M. collapsum. */

14. Redhorse Sucker - M. papillosum. */

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*/ Species of Moxostoma have been tentatively identified as these three species, They have been taken in hoop nets, gill nets, and rotenone samples. They are fairly abundant in the river. None of the suckers is of much value as a food fish, although Moxostoma and Minytrema are occasionally sold for food.

15. Spotted Sucker - Minytrema melanops. This sucker is fairly abundant. It is often taken in nets and baskets.

16. Lake Chubsucker - Erimyzon sucetta sucetta. This species is found in backwaters of tributary streams, sloughs, and flood plain lakes.

17. Carp - Cyprinus carpio. The carp appears occasionally in basket catches and seems to be only moderately abundant in the river. It is sometimes sold as food, but it is unimportant commercially when compared with the channel catfish.

18. Silvery Minnow - Hybognathus nuchalis regius. */

19. Spottail Shiner - Notropis hudsonius saludanus. */

20. Notropis leedsi. These minnows were frequently found in association with the following three species. It is the most abundant of the three.

21. Notropis callisema. These minnows are fairly common in quiet water areas of the river.

22. Notropis niveus. These minnows are fairly common in quiet water areas of the river.

23. Notropis maculatus. These minnows are fairly common in quiet water areas of the river.

24. Notropis petersoni. This minnow is abundant in clear tributary streams. It is found occasionally in both quiet and flowing water in the river.

25. Pugnose minnow - Opsopoeodus emiliae emiliae. This species is relatively scarce but widely distributed in the river.

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*/ These are the most abundant forage minnows in the river. They were frequently taken in seine and rotenone collections. H. nuchalis was the more widely dispersed of the two, being found both in quiet water areas and in fast-flowing water. N. hudsonius was found in greater numbers in fast water areas.

26. Golden Shiner - Notemigonus chrysoleucas bosci. This minnow is abundant in flood plain ponds. An occasional specimen was taken in collections made in the river proper.

27. Southern Channel Catfish - Ictalurus lacustris punctatus. This is the most important and intensively fished species in the river. It is the most abundant and valuable of the catfish in the river.

28. White Catfish - Ictalurus catus. This species is caught in baskets with the channel catfish. It is much less abundant than the preceding species.

29. Flat Bullhead - Ameiurus platycephalus. This catfish is regularly caught with the above two species. It is of little value as a food fish.

30. Yellow Bullhead - Ameiurus natalis erebennus.

31. Brown Bullhead - Ameiurus nebulosus marmoratus.

The above two species are found in quiet backwaters of the river and in floodplain ponds. Neither species appears to be very abundant.

32. Eastern Madtom - Schilbeodes marginatus marginatus.

33. Madtom - Schilbeodes leptacanthus.

These two diminutive catfish have been taken in brush boxes at several stations in the river and prefer fast water.

34. Tadpole Madtom - Schilbeodes mollis. This species was found in backwater areas of the river.

35. Chain Pickerel - Esox niger. This game-fish is present in tributary streams and quiet backwater areas of the river.

36. Redfin Pickerel - Esox americanus. This smaller pickerel is found in the same habitats as above species.

37. Ricefield Fish - Chologaster cornutus. This small species which burrows in the mud and organic debris of sloughs is very difficult to collect.

It was taken only in rotenone collection 2.

38. Starhead Topminnow - Fundulus dispar lineolatus. Although this species was taken only in flood plain ponds, it no doubt strays into the river proper occasionally.

39. Mosquitofish - Gambusia affinis holbrooki. This species is very abundant in shallow quiet waters of the river and in flood plain ponds.

40. Pirate Perch - Aphredoderus sayanus sayanus. The pirate perch is abundant in tributary streams and occasionally in the river.

41. Needlefish - Strongylura marina. A single specimen of this marine species was taken from a sand bar over 165 miles from the river mouth. Other specimens were observed in Upper Three Runs.

42. Hogchoker - Trinectes maculatus. This small flatfish, although normally considered a marine species, has been found as far as 170 miles up the Savannah River. It is common in the estuarine areas of the river.

43. Brook Silversides - Labidesthes sicculus. Silversides were taken occasionally in both fast and quiet-water areas of the river.

44. Striped Mullet - Mugil cephalus. This marine species is known to ascend the Savannah River, although none were collected by us. It is an important food species in estuarine areas along the coast.

45. Yellow Perch - Perca flavescens. This food fish is found in quiet backwaters from which it is taken occasionally by anglers.

46. Johnny Darter - Boleosoma nigrum subsp. This darter is fairly common on sand bars.

TABLE 22 - SAVANNAH RIVER STUDIES
Estuarine Sampling - April 22-24, 1952
Analytical Results

Date	Predicted Tides at S-0.0 Time	Description of Station	Drag No.	Time	Sample Depth	Temp. °F	O_2 ppm	Cl_2 ppm	% Sea Water
Apr. 22	High: 0634	N.of N.Jetty	1	0912	S	66	---	10,465	58
	1853				13'	--	---	10,829	57
	Low: 0029	Off Tybee Is.	3	1009	S	65	---	6,410	34
	1239				23	64	---	15,940	84
				1024	S	--	---	10,404	55
					23	--	---	15,344	81
			4	1044	S	--	---	5,123	27
					9'	65	---	15,940	84
		S.end S.Jetty	6	1206	S	66	---	2,343	12
					12'	66	---	5,317	28
			7	1248	S	--	---	1,530	8
					11'	65	---	1,663	9
		S.Channel Mile 3	8	1343	S	--	---	977	5
					11'	65	---	978	5
Apr. 23	High: 0720	N.Channel off Cockspur Is.	10	0858	S	65	6.47	6,580	35
	1937				39'	65	7.26	15,479	81
	Low: 0112								
	1323								
		N.Channel Buoys 22-24	11	0948	S	66	6.22	2,974	16
					12'	65	6.60	10,270	54
		Fields Cut	12	1124	S	65	5.69	3,132	16
					14'	66	5.22	4,674	25
		St.AugustineCr. Near Jct.Wilmington R.	14	1240	S	65	6.78	119	0.6
					15'	65	6.37	206	1.1
		Skidway R.	15	1402	S	69	6.95	5,499	29
					7'	69	6.63	8,049	42
				1417	S	70	7.10	8,292	44
					19	68	6.64	8,449	44
		Wilmington R. off Cen.Oglethorpe Hotel		1455	3.5	70	8.03	7,964	42
Apr. 24	High: 0802	Wassaw Sound off Wassaw Is.	18	(1002	S	69	6.86	8,207	43
	2012			(	S	69	6.76	14,738	78
	Low: 0158								
	1406	Off Petit Chou Island	20.	1107	S	69	7.08	14,143	74
			21	1137	S	--	6.86	12,480	66
					20	69	6.75	13,621	72
		Tybee RR & Lazaretta Cr.	23	1253	--	68	6.49	9,384	49
		Fields Cut		(1435	S	69	6.45	7,272	38
			24	(	10	68	6.09	7,308	38
				(1516	S	69	6.56	7,248	38
					10	69	6.42	7,296	38

TABLE 23 - SAVANNAH RIVER STUDIES - ESTUARINE COLLECTIONS APRIL 1954

Date	4/22									4/23 Catches not Totally Counted					4/24							Number of Collect'ns in which Present*/-
Drag No.	1	2	3	4	5	6	7	8	9	10-11	12-13	14	15-16	17	18	19	20	21	22	23	24	
Dasyatis sabina						1				1												2
Lepisosteus osseus											1											1
Brevoortia tyrannus		28		1	7	4				1	8				1							7
Anchoa mitchilli	2	1		1	1	12			1	2			13	14	71	60		1	55		3	14
Galeichthys felis				8		1				1									2	1		5
Urophycis regius	1	4		7	8	1				5									2			7
Lophopsetta aquosus															1			1				2
Ancylopsetta quadrocellata					1										1		1	1	3	2		6
Paralichthys dentatus						1		1					1									3
Etropus crossotus														1								1
Trinectes maculatus							30	33	16		1	3										5
Symphurus plagiusa		3		4	1	59	13			3							5	3	1	1		10
Trichiurus lepturus	3	3	1	1												1					1	6
Larimus fasciatus				1																		1
Bairdiella chrysura	1	1		13	3	5					2		9		1	1		1	12	3	5	13
Ctenellifer lanceolatus	4	38		19	500	32	2	1	43	350	7	3						11			8	13
Leiostomus xanthurus		4		19	5	7		1	1	3		1		14			33	9	18	4		13
Micropogon undulatus							1		3	1										1		4
Menticirrhus americanus				7		4									1							3
Cynoscion nothus	1		1												1							3
Micropogon undulatus										2												1
Trionotus carolinus																	1	2				2
Vomer setipinnis																			1			1
Peprilus paru	1	2		1	5					8					1	6		1				8
Opsanus tau														1								1
Malaclemmys centrata													3									1
Renilla reniformis	1	39	11	1		1									3		1	5	3			[illegible]

TABLE 23 - SAVANNAH RIVER STUDIES - ESTUARINE COLLECTIONS APRIL 1954 (Continued)

Date	4/22								4/23							4/24							Number of Collections in which Present*/
									Catches not Totally Counted														
Drag No.	1	2	3	4	5	6	7	8	9	10-11	12-13	14	15-16	17	18	19	20	21	22	23	24		
Gorgonidae													Pr.**										1
Ctenophora				Pr.	Pr.	Pr.																	3
Echiuroides																					1		1
Isopoda		1																					1
Chloridella empusa	1				2								1										3
Palaemonetes sp.													1										1
Crangonidae											1												1
Penaeus setiferus	6	34		6	13	25	8	4	2	8	42			3	13		4	1	3	6			16
Paguridae		1																1					1
Callinectes sapidus	9	11	1	17	4	6	2	25	4	5	3		15	1	7		4	3	6	3			18
Ovalipes ocellatus		1		10															1				3
Loligo sp.				5											2	11	1	3	27				6

*/ Total number of collections - 21 since 3 collections were duplicated

** = Present

Reproduced from best available copy.

47. Barratt's Darter - Hololepis barratti. Although this species is primarily a pond and swamp stream form, it was occasionally taken in the river.

48. Banded Pigmy Sunfish - Elassoma zonatum. This small species was found occasionally in back water areas.

49. Largemouth Black Bass - Micropterus salmoides. This widely-distributed game fish is most abundant in flood-plain ponds, sloughs, and quiet water areas of the river. It is one of the important sport species in the river.

50. Blue-spotted Sunfish - Enneacanthus gloriosus. This small sunfish was taken from sloughs along the river.

51. Little Sunfish - Enneacanthus obesus. Although this species was taken only from a flood plain pond, it undoubtedly strays into the river proper.

52. Flier - Centrarchus macropterus. This sunfish is abundant in flood plain ponds. It is occasionally found in sloughs along the river.

53. Warmouth - Chaenobryttus coronarius. */

54. White Crappie - Pomoxis annularis. */

55. Black Crappie - Pomoxis nigro-maculatus. */

56. Yellowbelly Sunfish - Lepomis auritus. */

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*/ These seven species of panfish are common throughout the river, and are frequently taken by sport fishermen. The bluegill is probably the most abundant of these species.

57. Bluegill - Lepomis macrochirus purpurescens. */

58. Florida Longear Sunfish - Lepomis marginatus. */

59. Redear Sunfish - Lepomis microlophus. */

60. Striped Bass - Roccus saxatilis. This anadromous fish is sometimes caught by commercial fishermen in baskets and gill nets. It is sought by sport fishermen in clear tributaries.

ESTUARINE STUDIES

Incidental to the collection of materials for radiological analysis from the estuarine areas at the mouth of the Savannah River, during April 1952, observations were made on the organisms encountered. Samples were taken from a 26-foot inboard motor boat employing a small otter-type trawl. This type of net which drags along the bottom is known as a "try net" in the southeastern shrimp fishery.

A series of 24 drags of fifteen minutes each was made in the estuarine areas which might be influenced by materials carried by the Savannah River.

Surface and bottom salinities and temperatures were measured in each area sampled. Beginning with drag number 10, dissolved oxygen was measured at each area sampled. Water samples for these analyses were taken at the beginning of each drag; and in areas where the conditions appeared to vary, at the end of the drag as well. These data are presented in Table 22.

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*/ Ibid. foregoing page.

Representatives of the more important species collected were prepared for radiological analyses. Other organisms collected were identified in order to obtain some information of the composition of the fauna of the estuarine area. This limited sampling, at one season, with highly selective gear, could not be expected to give any comprehensive picture of the populations of fish and other animals inhabiting this area. Nevertheless, some information was obtained on the occurrence of some of the important organisms present in the Savannah River estuary. Table 23 shows the numbers and kinds of organisms collected at each station.

The star drum (Stellifer lanceolatus) was the most abundant fish taken in these collections. It is a small fish, of no commercial value. The menhaden (Brevoortia tyrannus), spot (Leiostomus xanthurus), anchovy (Anchoa mitchilli), and silver perch (Bairdilla chrysura) were all fairly abundant in the collections. Of these, both the menhaden and the spot are of commercial value. The menhaden is used almost entirely for the manufacture of meal and oil. It supports a widespread commercial fishery along the Atlantic coast. The spot is an important food fish, being taken by both commercial and sport fishermen. Other food fish of sport and commercial value occurring less frequently in our catches were the silver squeteague (Cynoscion nothus), and the Atlantic croaker (Micropogon undulatus).

Blue crabs (Callinectes sapidus) and shrimp (Poneus setiferus) were the most widespread crustaceans collected. They were taken in most of the areas sampled. Both these crustaceans support extensive fisheries

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along the South Atlantic Coast. Some of this fishing takes place in the estuarine areas near the mouth of the Savannah River, commercial shrimping is conducted in Callibogue and Wassaw Sounds, and off Wassaw and Tybee Islands, and crab fishing is conducted in sounds and creeks throughout the area.

In addition to the organisms collected in the trawl samples, other species of commercial importance were observed in the estuarine areas. Extensive oyster beds (Crassostrea virginica) were present on the jetties at the mouth of the river and in areas adjacent to them. These beds are not utilized by man because of pollution in this area. The striped mullet (Mugil cephalus), which is an important sport and commercial species along the southern coast, is abundant in this area but it was not taken in the trawl samples.

CHAPTER VII

BACKGROUND RADIOACTIVITY OF WATER AND BIOTA

During this survey, 32 water, 282 fresh-water biota, and 438 estuarine biota samples were collected and shipped to Cincinnati for the assay of gross alpha and beta radioactivity. Radioactive assays were made on the dissolved and suspended solids of water samples and of the flesh and bony tissues of the biological samples.

The gross background radioactivity measurements include the isotopes of the naturally occurring uranium and thorium series, and natural beta emitting isotopes such as K^{40}. The radon group were probably excluded. Such an assay would also include artificially produced isotopes which had not decayed prior to analysis. To obtain such comparative data, 10 water samples were assayed within 2 weeks of collection, while 23 were assayed within one month, and the remaining nine within four months.

About forty per cent of the biological samples of flesh of fresh water organisms were analyzed during the first month. An additional 40 per cent were analyzed during the next two months, and the remainder in six to seven months. One half of the bone samples of fresh-water fish were analyzed within one month of collection, and the remainder after eight to ten months. The estuarine biological samples were analyzed five to six months after collection.

A resume of the maximum background radioactivity of samples collected from the Savannah River in this survey is presented in Table 30. The results show that the radioactivity density of biological tissues is

substantially greater than the radioactivity density of the water which provides a habitat for the biota.

RADIOACTIVITY OF WATER

Five water samples were tested in August 1951, when membrane filters were not available. The analyses were similar except that, when such filters were not available, one liter of water was filtered through a 5.5 cm. Whatman No. 5 filter paper in a small Buchner funnel. The suspended solids that were retained on the paper were dried with infra-red lamps and counted in the internal proportional counter.

The results of the alpha and beta radioactivity assays of the suspended solids and solids in solution in the water samples are presented in Table 24. The radioactivity is reported in micromicrocuries per liter plus or minus a precision of measurement equal to two standard deviations.

In discussing the radioactivity of water samples, it is convenient to refer to the radioactivity associated with the suspended solids as insoluble activity and the activity of the filtrate or dissolved solids as soluble activity.

The suspended solids alpha activity, shown in Table 24, varied from zero to a maximum of 4.1 $\pm$ 1.7 micromicrocuries per liter of water. The soluble alpha activity of the sample containing the maximum suspended activity was 0.1 $\pm$ 1.1. $\mu\mu$c/liter. Thus the total alpha activity of this sample was 4.2 $\pm$ 2.0 $\mu\mu$c/liter of water. Usually there was more insoluble than soluble alpha activity. However, in six out of 31 samples, the soluble alpha activity exceeded that in the suspended solids. The maximum soluble alpha activity was 8.4 $\pm$ 2.1 $\mu\mu$c/l. compared to 0.4 $\mu\mu$c/l. for the suspended solids fraction.

In those samples having a measurable alpha activity, the beta activity was appreciably higher in magnitude than the alpha activity. This is particularly true with respect to soluble activity. Thus, the maximum soluble beta activity was 31.8 $\pm$ 14.8 μμc/l. This sample had an insoluble beta activity of 8.6 $\pm$ 5.1 μμc/l. The maximum total beta activity occurred for this sample, and was 40.4 $\pm$ 15.6 μμc/l.

Table 2 of NBS Handbook 52* suggests the following provisional maximum concentrations of radioactive contaminants in water: for alpha emitters, 10^{-7} μc/ml., or 100 μμc/l.; for beta or gamma emitters, 10^{-7} μc/ml., or 100 μμc/l. These are in addition to natural background. This source further suggests application of a safety factor as large as 10 in the design and operation of permanent installations involving large quantities of radioactivity. Hence, in terms of gross activities, addition of as little as 10 μμc/l. of alpha or beta and gamma contamination is considered limiting.

In this survey, the median gross alpha activity observed in water was 1.0 μμc/l., with a maximum of 8.8 μμc/l. The median gross beta activity in water was 6.0 μμc/l., with a maximum of 40.4 μμc/l. Comparison of the suggested maximum permissible additions of radioactive material with the observed gross activities indicates clearly that the suggested standard does not permit major alteration of the natural background radioactivity levels.

* National Bureau of Standards, Handbook 52 "Maximum Permissible Amounts of Radioisotopes in the Human Body and Maximum Permissible Concentrations in Air and Water." (1953)

RADIOACTIVITY OF FRESH WATER BIOTA

The biological samples consist of bone and flesh samples of large fish, whole minnows, insect larvae and algae. The samples were sorted, weighed, and stored in vials in the field laboratory. Some samples were composited in the field. The perishable samples were frozen, packed in dry ice and shipped air express to Cincinnati. The samples were kept in a frozen condition until analyzed.

The radioactivity of the flesh and bony tissue of 40 individual or composite fish samples is presented in Table 25. The radioactivity of 7 composite samples of minnows and 5 algae samples is presented in Table 26, and the radioactivity of 17 samples of brush box organisms is presented in Table 27. The statistically significant results in these Tables show that the radioactivity of all samples exclusive of fish bone was less than 47 $\pm$ 28 μμc of alpha activity and less than 14.3 $\pm$ 5.6 μμc of beta activity per gram of wet weight sample. The minnows (whole fish samples) and the aquatic insects, all of which probably contained soil, showed a significant alpha activity. The algae showed no significant amount of alpha activity, but did show a measurable beta activity. The maximum alpha activity of fish flesh was 1.5 $\pm$ 0.9 μμc/g. The radioactivity of the ash of fish bone was less than the statistical error of the determination which varied from $\pm$ 2 to $\pm$ 28 μμc/gram for the alpha activity and $\pm$ 20 to $\pm$ 260 μμc/g. for beta activity.

RADIOACTIVITY OF ESTUARINE BIOTA

In April 1952, 438 samples of crabs, shrimps, oysters and fishes were collected and shipped to Cincinnati. The flesh samples were pro-

cessed for counting in a similar manner to the fresh water samples, except that larger samples amounting to as much as 5 grams of tissue were taken for analysis to improve the counting statistics of the test, with only a slight loss in the efficiency of counting due to self-absorption.

The results of 9 composite flesh samples representing 43 specimen of Blue Crab and 3 composite shell or claw samples representing 15 specimen collected from five areas at the mouth of the Savannah River are presented in Table 28. The radioactivity of the fleshy tissue of 8 composite samples of shrimp from 40 specimen and 2 composite samples of oysters from 10 specimen are also presented in Table 28.

The results of 32 composite flesh samples of fishes representing 135 specimen are presented in Table 29. Also included in Table 29 are the results of 14 composite bone samples from 62 specimen of fishes. The bone and shell of the estuarine samples were not entirely free of muscle tissue when they were processed according to the procedure given for fresh water bony tissue. */

Considering the results in Tables 28 and 29 the maximum alpha activity in flesh tissue was 0.22 $\pm$ 0.17 μμc/g. in an oyster sample. All but one composite estuarine flesh sample had a small but significant beta activity which may be attributed to K^{40} from salt water. The beta activity varied from 0.5 $\pm$ 0.2 μμc/g. in an oyster sample to 4.5 $\pm$ 1.1 μμc/g. in a fish sample. Except for one sample the alpha activity of bony tissue was less than the precision of the assay which varied from $\pm$ 2.4 to $\pm$ 15.7 μμc/g. of bone ash. Similarly the beta activity of bony

*/ See Appendix "E".

tissue was less than the precision of the assay which varied from ± 21 to ± 110 μμc/g. of bone ash.

MINIMUM DETECTABLE RADIOACTIVITY

Due to the statistical fluctuation of counting, the minimum detectable sample radioactivity (at a 95 per cent confidence level) is taken to be equal to twice the standard deviation of the net counting rate of the sample prior to the application of correction factors for backscatter and self-absorption. The over-all efficiency of counting in a 2 pi chamber was found to be 51 per cent for alpha activity and 73 per cent for beta activity, as determined with the use of urnaium and phosphorous ^{32} standards.

Suppose the instrument background for alpha counting is 0.32 cpm (counts per minute) and for beta 64 cpm, then the minimum detectable sample radioactivity would be 0.3 μμc for alpha and 2.5 μμc for beta radioactivity. The minimum detectable radioactivity per liter or gram depends on the size of the sample taken. The minimum detectable level of alpha and beta activity for a given sample type and size is as follows:

	Sample Size	Alpha	Beta
Water Samples			
Suspended Solids	0.5 liters	0.6 μμc/liter	5.0 μμc/liter
Dissolved Solids	0.2 liters	1.5 μμc/liter	12.5 μμc/liter
Biological Samples			
Flesh	200 mg.	1.5 μμc/g.	12.5 μμc/g.
Flesh	400 mg.	0.75 μμc/g.	6.2 μμc/g.
Flesh	750 mg.	0.53 μμc/g.	4.3 μμc/g.
Flesh	2,000 mg.	0.15 μμc/g.	1.25 μμc/g.
Bone Ash	20 mg.	15 μμc/g.	125 μμc/g.
Bone Ash	40 mg.	7.5 μμc/g.	62 μμc/g.

TABLE 24 - SAVANNAH RIVER STUDIES
RADIOACTIVITY OF SAVANNAH RIVER WATER SAMPLES

Location (River Mile)	Date Collected	Alpha Activity				Beta Activity			
		Suspended		Dissolved		Suspended		Dissolved	
		μμc/l	± μμc/l	μμc/l	± μμc/l	μμc/l	± μμc/l	μμc/l	± μμc/l
UTR*	12-28-51	3.1	5.9	-0.1	1.1	8.6	5.1	31.8	14.8
UTR*	10-23-51	0.8	0.6	0	1.3	5.7	5.0	2.5	10.3
LTR*	12-3-51	0.4	0.6	0	1.3	0	5.2	5.6	10.0
LTR*	2-6-52	0.7	0.5	0.0	1.2	-0.4	4.4	-4.9	9.2
ST*	11-7-51	0.2	0.1	0.2	0.5	1.5	0.6	-0.8	3.5
ST*	2-6-52	0.9	0.6	0.4	1.1	-0.7	4.4	10.5	9.2
Fo*	11-7-51	0.2	0.1	0.2	0.5	1.0	1.1	-2.9	3.4
Fo*	1-23-52	0.1	0.4	0.7	0.8	-2.1	4.8	-3.4	7.4
Fo*	2-18-52	1.0	0.7	-0.3	1.6	4.0	4.4	3.4	10.8
218.5	8-13-51	0.2	0.2	4.4	1.5	0.0	3.2	1.0	16.0
218.5	1-8-52	1.2	1.1	-0.3	1.2	10.8	10.1	7.7	7.7
215.6	8-13-51	0.0	0.2	0.0	1.1	0.0	3.2	12.4	16.0
203.3**	8-14-51	4.5	0.6	24.7	4.2	0.0	3.2	50.6	17.2
202.9	12-18-51	0.6	0.6	0.4	1.2	5.7	5.0	2.5	10.8
202.9	2-13-52	0.8	0.7	0.3	1.6	3.8	4.3	3.9	10.5
202.9	3-14-52	2.3	1.0	1.0	1.2	0.2	4.4	23.1	9.8
197	12-18-51	0.3	0.6	0.2	1.2	1.1	6.3	5.3	9.7
197	2-13-52	1.4	0.7	0.4	1.1	2.3	4.4	18.5	10.8
189	8-2-51	0.4	0.4	8.4	2.1	0.0	3.2	0	16.0
172	10-23-51	0.3	0.6	0.8	1.6	0	5.1	4.4	10.3
172	12-28-51	3.9	1.5	1.6	2.6	6.2	4.1	6.8	29.0
172	4-3-52	1.2	0.8	0.5	1.5	12.3	4.6	12.6	10.5
167	8-2-51	0.3	0.2	0.4	1.1	0.0	3.2	0	16.0
152	12-3-51	0	0.5	0	1.6	0	5.2	0	11.5
152	1-9-52	4.1	1.7	0.1	1.1	5.2	8.9	-3.7	7.7
152	4-3-52	1.3	0.7	1.7	2.2	13.2	6.3	12.6	11.1
52	12-6-51	0.8	0.6	0	1.4	2.9	5.2	0	10.9
52	2-20-52	1.7	0.8	0.0	1.2	3.8	4.3	0.0	10.5
52	4-9-52	1.4	0.7	2.5	2.3	-4.6	6.0	13.2	11.1
11x	12-6-51	0.4	0.6	0	1.3	0	5.2	96.	85.
11	3-12-52	0.9	0.7	0.0	1.6	5.9	4.3	-5.	19.
11	4-9-52	1.4	0.7	0.2	1.4	-4.2	6.0	3.7	11.1

* UTR - Upper Three Runs, LTR - Lower Three Runs, ST - Steel Creek, Fo - Four-Mile Branch.

** Laboratory contamination suspected.

x Excluded because high salinity caused large counting error.

Table No. 25

The Radioactivity of Fresh Water Fish

Savannah River 1951-1952

Specimen Kind	Numbers per Sample	Station River Mile	Month Collected	Radioactivity of flesh(1) Alpha μμc/g	± μμc/g	Beta μμc/g	± μμc/g	Radioactivity of bone(2) Alpha μμc/g	± μμc/g	Beta μμc/g	± μμc/g
Gar Family											
Lepisosteus osseus	3	146.4	Jan.	0.2	0.4	1.4	3.7	-0.5	2.7	11.1	21.6
" "	4	146.4	Jan.	0.0	0.2	1.2	1.3	-1.3	2.2	10	22
Bowfin Family											
Amia calva	2	146.4	Jan.	0.0	0.3	1.8	4.3	-	-	-	-
Herring (Shad) Family											
Alosa sapidissima	5	146.4	Jan.	0.0	0.4	0.4	0.3	1.4	2.5	15.7	21.6
Sucker Family											
Minytrema melanops	3	164.7	Jan.	0.5	0.4	-3.5	4.0	-0.9	5.2	-3.2	36
" "	10	137.5	Dec.	0.2	0.4	4.7	6.9	2	25	100	250
" "	1	136.4	Dec.	0.3	0.3	0.8	4.0	6	24	200	210
Moxostoma sp.	1	172.5	Jan.	0.1	0.5	-1.5	4.6	-	-	-	-
" "	1	170.3	Jan.	0.1	0.6	-0.9	5.1	-	-	-	-
" "	5	164.7	Jan.	0.0	0.3	3.4	2.2	5.8	5.8	-21	43
" "	5	164.7	Jan.	0.1	0.3	3.5	2.2	-0.2	4.8	-42	43
" "	1	154.7	Dec.	0.1	0.3	4.3	4.3	-	-	-	-
" "	1	137.5	Dec.	0.1	0.3	7.5	4.6	-5	20	6	250
" "	1	136.4	Dec.	0.0	0.3	2.6	4.6	-8	20	-40	250
Composite A	4		Jan.					0.0	2.0	15	22
Catfish Family											
Ameiurus nebulosus	3	175	Jan.	0.1	0.3	-3.9	3.9	-5.5	4.2	-22	36
" platycephalus	1	172.5	Jan.	1.5	0.9	-3.1	3.9	-	-	-	-
" "	1	171.6	Jan.	0.2	0.2	0.2	1.2	12	13	-	-
" "	3	170.3	Jan.	0.1	0.3	-3.0	4.0	-4.1	4.5	-36	36
Ictalurus catus	1	170.3	Jan.	-0.2	0.6	0.3	5.1	-	-	-	-

(continued)

Table No. 25 (continued)

The Radioactivity of Fresh Water Fish

Savannah River 1951-1952

Specimen Kind	Numbers per Sample	Station River Mile	Month Collected	Radioactivity of flesh(1) Alpha μμc/g	± μμc/g	Beta μμc/g	± μμc/g	Radioactivity of bone(2) Alpha μμc/g	± μμc/g	Beta μμc/g	± μμc/g
Catfish Family (Cont'd)											
Ictalurus lacustris	1	170.3	Jan.	0.1	0.6	-6.8	4.4	-	-	-	-
" "	4	171.6	Jan.	0.0	0.2	-2.0	3.0	-1.7	2.7	-2	27
" "	1	172.5	Jan.	0.1	0.6	-4.9	4.4	-	-	-	-
Ameiurus platycephalus	3	164.7	Jan.	0.1	0.3	-6.5	3.8	0.9	4.8	13	34
" "	1	163.8	Dec.	0.2	0.3	3.7	4.3	27	27	-100	250
Ictalurus catus	1	164.7	Jan.	0.4	0.6	1.1	4.9	-3.3	4.5	-67	110
Ictalurus lacustris	5	164.7	Jan.	0.2	0.3	2.9	2.2	-2.7	1.9	-13	23
" "	5	164.7	Jan.	0.2	0.3	2.5	2.2	-1.4	2.0	-6	22
" "	10	163.8	Dec.	0.1	0.4	2.1	4.4	8	22	130	260
Ameiurus platycephalus	2	154.7	Dec.	0.2	0.4	8.3	4.3	31	27	75	260
Ictalurus catus	1	154.7	Dec.	0.1	0.3	-0.3	4.5	19	27	3	250
Ictalurus lacustris	6	155.8	Dec.	-0.1	0.4	-0.9	4.1	18	28	80	250
" "	10	154.7	Jan.	0.4	0.5	3.3	4.3	19	25	25	260
Ameiurus platycephalus	1	137.5	Jan.	0.2	0.4	1.1	5.9	-11	22	-140	250
" "	1	136.4	Jan.	0.2	0.4	-1.1	5.6	-3	21	220	240
Ictalurus catus	1	137.5	Dec.	0.2	0.3	11.6	4.5	27	32	220	110
Ictalurus lacustris	2	137.5	Jan.	-0.1	0.4	3.6	6.9	11	23	6	250
" "	8	136.4	Jan.	0.1	0.4	-0.7	7.2	-11	22	-360	250
Composite B	7		Jan.					2.7	2.7	-5	20
Sunfish (Bass) Family											
Micropterus salmoides	2	146.4	Jan.	-0.1	0.3	-2.3	2.2	-	-	-	-

NOTE: (1) Per gram of tissue. (2) Per gram of ignited bone.

TABLE NO. 20 The Radioactivity of Fresh Water Minnows and Algae

Savannah River 1951-1952

Specimen		Station River Mile	Month Collected	Radioactivity*			
				Alpha		Beta	
Kind	Numbers per Sample			μμc/g	±μμc/g	μμc/g	±μμc/g
Minnows							
Hybognathus nuchalis	5	167.7	Jan.	0.6	0.3	3.2	2.5
" "	5	167.7	Jan.	0.3	0.3	1.4	2.4
Notropis hudsonius	2	167.7	Jan.	2.6	1.0	2.8	4.7
" "	2	167.7	Jan.	3.2	1.1	8.7	5.0
"	1	167.7	Jan.	0.8	1.6	4.0	9.5
"	5	167.7	Jan.	0.7	0.4	4.9	2.5
Notropis sp.	10	148.3	Jan.	-0.1	0.2	8.1	2.8
Algae							
Vaucheria sp.		171.[illegible]	Jan.	0.4	1.3	7.9	15.3
Stigeoclonium sp.		165.4	Jan.	-0.5	0.6	13.4	5.4
Vaucheria sp.		165.4	Jan.	-0.1	0.7	0.8	8.2
Audouinella sp.		165.4	Jan.	-0.4	0.6	14.3	5.6
Algae		148.[illegible]	Jan.	3.4	3.6	-9.3	27.1

Note. * Per gram of whole fish or moist (blotted) sample.

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TABLE NO. 27 The Radioactivity of Fresh Water Brush Box Organisms

Savannah River 1951-1952

Specimen			Radioactivity			
Kind	Station	Month Collected	Alpha uuc/g	±uuc/g	Beta uuc/g	±uuc/g
Annelida (Aquatic earthworms)	Fo	Dec.	6.4	11.2	-25	109
Coleoptera (Beetles)	UTR	Dec.	47	28	156	217
Diptera (Two-winged flies)	Fo	Dec.	0.0	20	-129	187
"	UTR	Dec.	1.9	3.8	6.7	37
"	UTR	Nov.	3.0	12.0	33	134
Ephemerida (Mayflies)	Fo	Dec.	-0.4	2.5	-8.9	30.6
"	UTR	Dec.	1.3	1.6	4.7	13.9
"	UTR	Nov.	1.3	1.7	7.3	15.8
Neuroptera (Lace-wings)	UTR	Dec.	1.6	0.9	8.6	5.7
"	163.8	Dec.	0.5	0.5	0.6	4.0
Odonata (Dragonflies)	UTR	Nov.	2.6	2.1	1.3	17.2
Plecoptera (Stoneflies)	UTR	Dec.	0.3	0.7	-5	5.4
"	163.8	Dec.	0.2	2.5	3.1	30
Trichoptera (Caddis flies)	Fo	Dec.	3.9	4.7	-23.1	39.2
"	UTR	Dec.	4.8	3.9	11.5	32
"	163.8	Dec.	0.3	0.6	7.9	5.5
"	UTR	Nov.	3.1	2.4	7.8	19.0

Note: * Four Mile Creek (Fo), Upper Three Runs (UTR).
** Per gram of moist (blotted) sample.

TABLE 28 - The Radioactivity of Crabs, Oysters and Shrimp Found in Savannah River Estuaries April 1952

Specimen: Kind	Numbers per Sample	Station*	Radioactivity of Flesh(1): Alpha μμc/g	± μμc/g	Beta μμc/g	± μμc/g	Radioactivity of Shell(2): Alpha μμc/g	± μμc/g	Beta μμc/g	± μμc/g
Crustacea										
Callinectes sapidus, (Blue crab)	5	A	0.04	0.06	2.3	0.5	0.5	2.9	-12	28
" "	5	A	0.04	0.06	2.0	0.4	2.2	3.2	-72	27
" "	4	B	-0.04	0.15	2.3	1.1				
" "	5	B	-0.11	0.11	3.0	0.9				
" "	4	B	0.02	0.13	2.2	0.9				
" "	5	C-D	0.11	0.16	2.3	1.0	1.0	5.7	-33	37
" "	5	D	0.01	0.14	2.1	1.0				
" "	5	E	-0.11	0.12	3.0	1.0				
" "	5	E	-0.02	0.15	2.0	1.0				
Penaeus setiferus, (Shrimp)	5	A	0.03	0.07	1.6	0.5				
"	5	A	0.03	0.07	1.6	0.5				
"	5	A	0.00	0.07	1.8	0.5				
"	5	B	-0.02	0.08	2.3	0.5				
"	5	B	-0.02	0.08	2.4	0.6				
"	5	C	0.09	0.06	2.2	0.5				
"	5	C	0.04	0.05	2.6	0.5				
"	5	D	0.00	0.07	1.8	0.5				
Mollusca										
Ostrea virginica, (Oyster)	5	A	0.19	0.06	0.9	0.2				
"	5	A	0.13	0.05	0.[illegible]	0.2				

Note: * Mouth of savannah River off Savannah Beach (A); Off Long Island at midlength (B); at Fields Cut (C), near mouth of Wilmington and Skidaway Rivers (D), Wassaw Sound off Cabbage Island (E).
(1) Per gram of flesh.
(2) Per gram of ignited shell or claw.

TABLE NO. 29

The Radioactivity of Fish Found in the Savannah River Estuaries April 22-24, 1952

Specimen Kind	Numbers per Sample	Station*	Radioactivity of Flesh(1) Alpha uuc/g	± uuc/g	Beta uuc/g	± uuc/g	Radioactivity of Bone(2) Alpha uuc/g	± uuc/g	Beta uuc/g	± uuc/g
Phycis regius (Hake)	3	A	-0.03	0.06	2.4	0.4	-4.4	15.7	-230	110
" "	3	A	0.02	0.14	1.4	0.7	-2.8	4.4	-31	36
"	3	B	0.00	0.10	3.4	0.8	1.8	5.7	-28	37
Brevoortia smithi, (Menhaden)	5	A	0.22	0.17	4.5	1.1	-3.1	2.4	-39	26
"	5	A	-0.01	0.09	2.8	0.6	-1.1	2.7	-9	22
"	5	A/D	0.08	0.07	3.4	0.5	-	-	-	-
"	5	C/E	0.01	0.05	3.0	0.5	-	-	-	-
Bairdella chrysura, (Silver perch)	5	A	-0.06	0.10	2.4	0.8	-	-	-	-
" "	4	C	0.04	0.08	1.9	0.6	-	-	-	-
" "	5	C	0.06	0.07	2.2	0.5	-	-	-	-
" "	5	D	-0.02	0.06	2.6	0.5	-	-	-	-
" "	4	D	-0.03	0.08	1.9	0.5	-	-	-	-
" "	5	E	0.03	0.05	3.0	0.8	1.7	3.9	-43	27
" "	5	E	0.05	0.05	2.7	0.5	0.3	2.9	-16	21
Leiostomus xanthurus (Spotted croaker)	5	A	0.03	0.07	2.7	0.5	-0.3	2.5	-42	22
" "	5	A	0.01	0.07	2.5	0.5	-0.3	2.5	-56	21
" "	5	B	0.09	0.07	2.3	0.5	-	-	-	-
" "	4	D	0.03	0.10	2.3	0.6	-	-	-	-
" "	4	D	0.03	0.10	1.8	0.6	-	-	-	-
" "	5	E	-0.06	0.07	1.9	0.5	4.1	3.4	-3	21
" "	5	E	-0.07	0.07	2.0	0.5	0.0	2.7	-3	21

(Continued)

TABLE NO. 29 (Con't)

The Radioactivity of Fish Found in the

Savannah River Estuaries April 22-24, 1952

Specimen Kind	Numbers per Sample	Station*	Radioactivity of Flesh(1) Alpha μμc/g	± μμc/g	Beta μμc/g	± μμc/g	Radioactivity of Bone(2) Alpha μμc/g	± μμc/g	Beta μμc/g	± μμc/g
Menticerrhus americanus, (King croaker)	4	A	0.08	0.07	2.8	0.5	-2.0	11.2	-57	83
Micropogon undulatus, (croaker)	3	D	-0.01	0.04	1.7	0.4	-	-	-	-
"	3	D	0.00	0.04	1.8	0.4	-	-	-	-
Peprilus paru, (Harvest fish)	5	A	0.22	0.31	2.3	2.3	1.2	3.2	-12.2	21.8
" "	4	A	0.23	0.38	2.9	2.9	2.2	4.8	-12.3	32.8
"	3	A/D	0.13	0.10	2.9	0.8	-	-	-	-
" "	4	B	0.05	0.08	3.0	0.6	-	-	-	-
" "	4	B	0.06	0.08	2.8	0.6	-	-	-	-
" "	4	D	0.06	0.11	1.7	0.6	-	-	-	-
" "	4	D	0.10	0.11	1.5	0.7	-	-	-	-
Cynoscion regalis, (Weak fish)	1	E	0.04	0.13	2.2	0.9	-	-	-	-

Note: * Mouth of Savannah River off Savannah Beach (A), Off Long Island at midlength (B), at Fields Cut(C), near mouth of Wilmington and Skidaway Rivers (D), Wassaw Sound off Cabbage Island (E).
(1) Per gram of flesh.
(2) Per gram of ignited bone.

TABLE 30

The Maximum Radioactivity Density
of the Savannah River Samples

1951-1952

Sample type	Alpha Radioactivity		Beta Radioactivity	
	uuc/g	± uuc/g	uuc/g	± uuc/g
Fresh Water				
In suspended solids	0.0041*	0.0017	0.0132*	0.0006
In dissolved solids	0.0084*	0.0021	0.0318*	0.0148
Fresh Water Organisms				
Fish Flesh	1.5	0.9	11.6	4.5
Minnows (whole fish)	3.2	1.1	8.7	5.0
Aquatic Insects	47.	28.	8.6	5.7
Algae	3.4	3.6	14.3	5.6
Estuarine Organisms				
Crab flesh	0.11	0.16	3.0	0.9
Shrimp flesh	0.09	0.06	2.6	0.5
Oyster flesh	0.19	0.06	0.9	0.2
Fish flesh	0.22	0.17	4.5	1.1

Note: *Per milliliter of water

APPENDIX "A"

SUMMARY OF INDIVIDUAL RESULTS - SANITARY EXAMINATIONS

SAVANNAH RIVER STUDIES

Summary of Individual Results - Sanitary Examinations

Sampling Point		Date 1951	Disch. at Augusta Sec-Ft	O.C. Moore ppm	5-Day 20°C BOD ppm	Temp. °C	Turb. ppm	Color ppm	Dissolved Oxygen ppm	Dissolved Oxygen % Sat	pH	Alkal. ppm	Chloride ppm	Coliforms MPN per 100 ml Ga.	Coliforms MPN per 100 ml S.C.
S 230.7	M.S.	8/9	2,960	6.0	0.25	--	70	15	7.0	--	7.1	2	4.1	230	
	M.S.	8/14	3,800	4.1	0.31	30	42	15	7.0	92	7.3	19	3.2	930	
	M.S.	8/23	2,790	5.0	0.62	30	80	20	7.0	91	7.3	17	3.3	230	
	M.S.	9/18	4,100	6.5	0.31	23	93	20	8.0	92	7.6	19	3.6	2,300	
*S 223.6; AgC 3.4		8/9		2.9	0.23	--	66	50	6.8	--	7.2	17	3.0	210	
		8/14		4.4	0.49	30	37	10	7.1	93	7.2	17	3.2	930	
		8/23		4.9	0.51	29	85	20	6.9	88	7.3	17	3.2	1,500	
		9/18		5.1	0.41	24	86	20	7.4	87	7.5	18	3.4	4,300	
S 218.5	Ga.	7/30	4,800	8.4	0.43	--	48	40	7.2	--	7.4	19	2.2	750	
	M.S.	7/30	4,800	6.7	0.47	--	37	32	7.4	--	7.5	20	2.8	230	
	S.C.	7/30	4,800	8.3	0.19	--	36	28	7.3	--	7.5	19	2.7	430	
	Ga.	8/13	3,580	5.1	0.26	30	36		6.8	89	7.4	19	2.4	91	
	M.S.	8/13	3,580	4.4	0.37	30	34	10	7.0	91	7.4	19	2.8	360	
	S.C.	8/13	3,580	---	0.43	30	32		7.0	91	7.5	18	2.7	2,400	
	M.S.	8/22	3,470	5.4	0.20	30	65	20	6.7	88	7.4	17	3.2	430	
	M.S.	9/11	2,800	4.2	0.44	27	27	10	7.3	90	7.6	18	2.9	230 2,300	750
	M.S.	9/24	4,720	1.6	0.48	25	48	20	8.0	95	7.5	20	3.5	930 1,500	230
	M.S.	10/8	2,560	7.4	0.27	25	83	28	7.6	90	7.4	17	4.2	2,300 --	930
	M.S.	10/15	2,360	3.0	0.26	19	37	33	8.8	94	7.5	20	3.5	91 --	230
	M.S.	10/24	1,960	4.0	0.22	21	33	28	8.5	94	7.5	19	3.8	93 --	240
	M.S.	10/29	3,840	4.2	0.37	19	28	17	8.6	92	7.5	19	3.9	930 --	930
	M.S.	12/4	4,840	2.9	0.31	11	8	28	11.0	99	6.9	16	3.9	430 --	150
	M.S.	12/10	5,460	9.5	0.55	14	180	140	10.2	98	7.1	13	3.6	2,400 --	2,400
	M.S.	12/19	9,990	6.1	0.37	6	65	56	12.4	99	7.1	15	3.4	4,600 --	4,600
	M.S.	12/26	14,300	20	0.85	7	310	136	12.5	103	6.7	7	2.6	24,000 --	4,300

* By waterworks intake in Augusta Canal. This is 3.4 miles downstream from source of Canal at S 223.6

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SAVANNAH RIVER STUDIES
Summary of Individual Results - Sanitary Examinations

Sampling Point		Date	Disch. at Augusta Sec-Ft	O.C. Moore ppm	5-day 20°C BOD ppm	Temp. °C	Turb. ppm	Color ppm	Dissolved Oxygen ppm	Dissolved Oxygen % Sat	pH	Alkal. ppm	Chloride ppm	Coliforms MPN per 100 ml Ga.	Coliforms MPN per 100 ml S.C.
		1952													
S 218.5	M.S.	1/2	14,000	13	0.70	9	155	136	12.3	106	7.2	8	2.9	430 --	230
(Continued)	M.S.	1/8	12,800	8.1	0.45	8	73	116	11.9	100	7.1	11	3.2	93 --	93
	M.S.	1/14	11,400	8.1	0.84	10	60	136	11.6	102	6.9	11	3.4	93 --	230
	M.S.	1/21	5,410	11	0.42	10	38	92	11.1	98	7.0	12	3.3	230 --	430
	M.S.	2/11	5,260	10	1.2	12	58	160	10.8	100	7.3	13	3.8	4,600 --	4,600
	M.S.	3/5	37,900	23	2.1	11	375	96	11.1	100	7.0	9	2.9	4,300 --	9,300
		1951													
S 217.78,	M.S.	7/30		7.0	0.92	--	41	35	7.0	--	7.2	19	2.4	< 110,000	
SMG 0.01	M.S.	8/13		6.4	1.3	30	48	10	6.9	90	7.3	18	2.6	93,000	
	M.S.	8/22		7.7	2.2	30	75	20	6.7	88	7.3	17	3.5	1,100,000	
	M.S.	9/11		6.5	>7.0	27	43	15	7.0	87	7.5	18	3.6	430,000	
	M.S.	9/24		8.3	1.8	24	72	25	7.6	90	7.5	19	6.1	430,000	
	M.S.	10/15		4.1	0.74	20	44	26	8.8	96	7.4	19	4.1	3,600	
	M.S.	12/4		7.5	1.0	12	47	31	11.4	105	7.1	13	3.8	150,000	
		1952													
	M.S.	1/2		14	1.8	8	145	128	12.3	104	6.8	7	3.0	--	
		1951													
S 217.6,	M.S.	7/30		5.6	0.48	--	30	30	6.9	--	7.4	19	2.5	24,000	
KMG 0.01	M.S.	8/13		4.8	0.64	30	37	12	6.9	91	7.3	19	2.7	24,000	
	M.S.	8/22		5.2	0.07	30	80	20	6.5	85	7.3	16	2.9	4,300	
	M.S.	9/11		6.4	2.1	27	36	15	7.3	90	7.5	19	3.2	93,000	
	M.S.	9/24		2.4	0.85	24	70	20	8.0	94	7.4	18	3.3	9,300	
	M.S.	10/8		13	3.9	24	83	24	7.2	84	7.6	21	4.7	460,000	
	M.S.	12/10		11	0.94	13	185	128	10.2	96	7.1	13	3.6	93,000	
		1952													
	M.S.	1/8		8.1	0.71	8	78	112	11.9	100	7.1	10	3.1	9,300	
		1951													
S 217.2,	M.S.	7/30		7.4	1.0	--	35	34	7.0	--	7.2	19	2.4	<110,000	
HGG 0.01	M.S.	8/13		4.7	1.1	30	40	12	6.9	90	7.3	18	3.2	240,000	
	M.S.	9/11		9.2	>7.0	27	30	15	7.0	87	7.5	20	4.8	230,000	

SAVANNAH RIVER STUDIES

Summary of Individual Results - Sanitary Examinations

Sampling Point		Date	Disch. at Augusta Sec-Ft	O.C. Moore ppm	5-Day 20°C BOD ppm	Temp. °C	Turb. ppm	Color ppm	Dissolved Oxygen ppm	Dissolved Oxygen % Sat	pH	Alkal. ppm	Chloride ppm	Coliforms MPN per 100 ml Ga.	Coliforms MPN per 100 ml	Coliforms MPN per 100 ml S.C.
		1951														
S 217.2;	M.S.	9/24		6.0	1.0	24	81	20	7.8	91	7.7	21	3.4		93,000	
HGG 0.01	M.S.	10/15		5.2	1.2	19	40	31	8.7	81	7.4	19	3.8		430,000	
(Cont'd)	M.S.	12/10		15	0.87	13	190	108	10.1	95	6.8	11	5.0		93,000	
		1952														
	M.S.	1/8		9.4	1.2	8	73	104	11.6	98	7.0	9	3.3		24,000	
		1951														
S 215.6	Ga.	7/30	4,800	4.2	0.44	--	60	32	6.9	--	7.2			24,000		
	M.S.	7/30	4,800	5.5	0.35	--	60	37	6.9	--	7.3	20	1.7		46,000	
	S.C.	7/30	4,800	7.6	0.40	--	60	38	6.9	--	7.3					46,000
	Ga.	8/13	3,580	3.8	0.46	31	36		6.6	88	7.4	18	2.2	43,000		
	M.S.	8/13	3,580	3.4	0.56	31	37	12	6.6	88	7.4	19	2.0		93,000	
	S.C.	8/13	3,580	3.0	0.54	31	37		6.6	88	7.4	19	2.2			43,000
	Ga.	8/22	3,470	5.5	0.07	30	80		6.3	84	7.3	16	3.0	43,000		
	M.S.	8/22	3,470	6.2	0.44	30	80	20	6.7	88	7.3	15	3.2		93,000	
	S.C.	8/22	3,470	5.0	0.16	30	83		6.4	84	7.3	14	2.7			43,000
	M.S.	9/11	2,800	4.5	0.73	27	27	10	7.2	90	7.6	18	3.2	240,000	210,000	23,000
	M.S.	9/24	4,720	0.83	0.77	24	55	25	7.8	91	7.6	19	3.8	23,000	93,000	43,000
S 213.36;	M.S.	8/9		42	11	--	39	110	0	--	8.3	100	5.5		43,000	
Ho 2.7	M.S.	8/15		31	11	28	32	80	2.5	32	8.5	50	5.4		430,000	
S 213.36;	M.S.	8/22		41	>23	28	25	80	0	0	8.5	41	8.3		430,000	
Ho 0.01	M.S.	9/11		27	6.5	25	<25	70	0.16	2	7.8	69	5.5		430,000	
	M.S.	9/26		20	7.4	22	7	80	2.9	33	7.8	57	5.3		43,000	
	M.S.	10/8		20	2.7	22	7	60	3.4	38	7.7	60	5.5		240,000	
	M.S.	12/4		44	14	14	4	58	2.5	24	7.7	61	5.5		9,300	
		1952														
	M.S.	1/2		32	8.9	14	4	72	2.8	27	7.5	44	4.5		230	
	M.S.	2/11		16	4.5	13	2	50	4.2	40	7.8	45	5.1		15,000	
	M.S.	3/5		15	4.0	12	93	80	6.3	58	7.2	13	3.4		7,500	

SAVANNAH RIVER STUDIES
Summary of Individual Results - Sanitary Examinations

Sampling Point		Date	Disch. at Augusta Sec-Ft	O.C. Moore ppm	5-Day 20°C BOD ppm	Temp. °C	Turb. ppm	Color ppm	Dissolved Oxygen ppm	Dissolved Oxygen % Sat	pH	Alkal. ppm	Chloride ppm	Coliforms MPN per 100 ml Ga.	Coliforms MPN per 100 ml	Coliforms MPN per 100 ml S.C.
		1951														
S 212.0	Ga.	8/13	3,580	3.2	0.47	31	36		6.4	86	7.2	18	2.5	93,000		
	M.S.	8/13	3,580	2.9	0.54	31	37	12	6.3	84	7.3	20	2.4		43,000	
	S.C.	8/13	3,580	4.2	0.70	31	38		6.4	86	7.3	20	2.6			43,000
	Ga.	8/22	3,470	5.3	0.64	30	80		6.1	80	7.4	15	3.3	150,000		
	M.S.	8/22	3,470	5.4	0.96	30	82	25	6.1	80	7.3	16	3.2		75,000	
	S.C.	8/22	3,470	5.6	0.61	30	81		6.1	80	7.3	15	3.3			93,000
	Ga.	9/12	2,080	5.0	1.1	28	<25		5.5	70	7.7	23	4.0	240,000		
	M.S.	9/12	2,080	4.0	1.1	28	<25	15	6.0	76	7.7	21	3.9		460,000	
	S.C.	9/12	2,080	3.6	1.2	28	<25		6.1	77	7.7	21	3.4			460,000
	Ga.	9/26	6,030	6.3	0.83	27	85	43	6.8	84	7.5	19	3.9	230,000		
	M.S.	9/26	6,030	7.6	1.1	26	83	40	7.0	85	7.5	20	4.2		23,000	
	S.C.	9/26	6,030	6.1	1.1	26	67	40	6.8	83	7.5	24	3.6			23,000
	M.S.	10/8	2,560	10	0.49	26	78	25	6.9	84	7.3	20	4.5	93,999	93,000	93,000
	M.S.	10/15	2,360	6.1	0.51	19	32	37	8.0	86	7.5	22	10	43,000	43,000	93,000
	M.S.	10/24	1,960	6.9	1.2	19	28	27	7.1	76	7.4	24	4.4	150,000	240,000	240,000
	M.S.	10/29	3,840	5.6	0.57	19	25	26	7.7	83	7.5	23	3.8	24,000	93,000	9,300
	M.S.	12/4	4,840	7.5	0.16	11	11	30	10.8	97	7.0	15	4.2	43,000	29,000	24,000
	M.S.	12/10	5,460	10	0.66	14	180	120	9.6	93	7.0	13	3.6	43,000	43,000	43,000
	M.S.	12/19	9,990	5.4	0.50	6	62	50	12.3	99	7.0	13	3.3	43,000	43,000	9,300
	M.S.	12/26	14,300	18	1.0	7	330	128	12.4	102	7.0	8	3.0	24,000	4,300	2,300
		1952														
	M.S.	1/2	14,000	13	1.1	9	155	128	12.2	105	7.0	8	2.9	4,300	910	<360
	M.S.	1/8	12,800	7.9	0.51	8	68	108	11.7	99	7.2	10	3.4	15,000	750	240
	M.S.	1/14	11,400	7.5	0.57	10	63	116	11.5	101	6.8	10	3.3	4,300	1,500	2,300
	M.S.	1/21	5,410	9.4	0.72	11	40	88	10.5	95	7.2	14	4.2	46,000	24,000	15,000
	M.S.	2/11	5,260	5.6	0.54	11	63	120	11.0	99	7.4	13	3.2	230	230	430
	M.S.	3/5	37,900	24	2.1	11	440	80	10.9	98	6.9	9	3.5	4,300	2,300	9,300

SAVANNAH RIVER STUDIES
Summary of Individual Results - Sanitary Examinations

Sampling Point		Date	Disch. at Augusta Sec-Ft	O.C. Moore ppm	5-Day 20°C BOD ppm	Temp. °C	Turb. ppm	Color ppm	Dissolved Oxygen ppm	Dissolved Oxygen % Sat	pH	Alkal. ppm	Chloride ppm	Coliforms MPN per 100 ml Ga.	Coliforms MPN per 100 ml	Coliforms MPN per 100 ml S.C.
		1951														
S 217.2;	M.S.	9/24		6.0	1.0	24	81	20	7.8	91	7.7	21	3.4		93,000	
HGG 0.01	M.S.	10/15		5.2	1.2	19	40	31	8.7	81	7.4	19	3.8		430,000	
(Cont'd)	M.S.	12/10		15	0.87	13	190	108	10.1	95	6.8	11	5.0		93,000	
		1952														
	M.S.	1/8		9.4	1.2	8	73	104	11.6	98	7.0	9	3.3		24,000	
		1951														
S 215.6	Ga.	7/30	4,800	4.2	0.44	--	60	32	6.9	--	7.2			24,000		
	M.S.	7/30	4,800	5.5	0.35	--	60	37	6.9	--	7.3	20	1.7		46,000	
	S.C.	7/30	4,800	7.6	0.40	--	60	38	6.9	--	7.3					46,000
	Ga.	8/13	3,580	3.8	0.46	31	36		6.6	88	7.4	18	2.2	43,000		
	M.S.	8/13	3,580	3.4	0.56	31	37	12	6.6	88	7.4	19	2.0		93,000	
	S.C.	8/13	3,580	3.0	0.54	31	37		6.6	88	7.4	19	2.2			43,000
	Ga.	8/22	3,470	5.5	0.07	30	80		6.3	84	7.3	16	3.0	43,000		
	M.S.	8/22	3,470	6.2	0.44	30	80	20	6.7	88	7.3	15	3.2		93,000	
	S.C.	8/22	3,470	5.0	0.16	30	83		6.4	84	7.3	14	2.7			43,000
	M.S.	9/11	2,800	4.5	0.73	27	27	10	7.2	90	7.6	18	3.2	240,000	210,000	23,000
	M.S.	9/24	4,720	0.83	0.77	24	55	25	7.8	91	7.6	19	3.8	23,000	93,000	43,000
S 213.36;	M.S.	8/9		42	11	--	39	110	0	--	8.3	100	5.5		43,000	
Ho 2.7	M.S.	8/15		31	11	28	32	80	2.5	32	8.5	50	5.4		430,000	
S 213.36;	M.S.	8/22		41	>23	28	25	80	0	0	8.5	41	8.3		430,000	
Ho 0.01	M.S.	9/11		27	6.5	25	<25	70	0.16	2	7.8	69	5.5		430,000	
	M.S.	9/26		20	7.4	22	7	80	2.9	33	7.8	57	5.3		43,000	
	M.S.	10/8		20	2.7	22	7	60	3.4	38	7.7	60	5.5		240,000	
	M.S.	12/4		44	14	14	4	58	2.5	24	7.7	61	5.5		9,300	
		1952														
	M.S.	1/2		32	8.9	14	4	72	2.8	27	7.5	44	4.5		230	
	M.S.	2/11		16	4.5	13	2	50	4.2	40	7.8	45	5.1		15,000	
	M.S.	3/5		15	4.0	12	93	80	6.3	58	7.2	13	3.4		7,500	

SAVANNAH RIVER STUDIES

Summary of Individual Results - Sanitary Examinations

Sampling Point		Date	Disch. at Augusta Sec-Ft	O.C. Moore ppm	5-Day 20°C BOD ppm	Temp. °C	Turb. ppm	Color ppm	Dissolved Oxygen ppm	Dissolved Oxygen % Sat	pH	Alkal. ppm	Chloride ppm	Coliforms MPN per 100 ml Ga.	Coliforms MPN per 100 ml	Coliforms MPN per 100 ml S.C.
		1951														
S 212.0	Ga.	8/13	3,580	3.2	0.47	31	36		6.4	86	7.2	18	2.5	93,000		
	M.S.	8/13	3,580	2.9	0.54	31	37	12	6.3	84	7.3	20	2.4		43,000	
	S.C.	8/13	3,580	4.2	0.70	31	38		6.4	86	7.3	20	2.6			43,000
	Ga.	8/22	3,470	5.3	0.64	30	80		6.1	80	7.4	15	3.3	150,000		
	M.S.	8/22	3,470	5.4	0.96	30	82	25	6.1	80	7.3	16	3.2		75,000	
	S.C.	8/22	3,470	5.6	0.61	30	81		6.1	80	7.3	15	3.3			93,000
	Ga.	9/12	2,080	5.0	1.1	28	<25		5.5	70	7.7	23	4.0	240,000		
	M.S.	9/12	2,080	4.0	1.1	28	<25	15	6.0	76	7.7	21	3.9		460,000	
	S.C.	9/12	2,080	3.6	1.2	28	<25		6.1	77	7.7	21	3.4			460,000
	Ga.	9/26	6,030	6.3	0.83	27	85	43	6.8	84	7.5	19	3.9	230,000		
	M.S.	9/26	6,030	7.6	1.1	26	83	40	7.0	85	7.5	20	4.2		23,000	
	S.C.	9/26	6,030	6.1	1.1	26	67	40	6.8	83	7.5	24	3.6			23,000
	M.S.	10/8	2,560	10	0.49	26	78	25	6.9	84	7.3	20	4.5	93,999	93,000	93,000
	M.S.	10/15	2,360	6.1	0.51	19	32	37	8.0	86	7.5	22	10	43,000	43,000	93,000
	M.S.	10/24	1,960	6.9	1.2	19	28	27	7.1	76	7.4	24	4.4	150,000	240,000	240,000
	M.S.	10/29	3,840	5.6	0.57	19	25	26	7.7	83	7.5	23	3.8	24,000	93,000	9,300
	M.S.	12/4	4,840	7.5	0.16	11	11	30	10.8	97	7.0	15	4.2	43,000	29,000	24,000
	M.S.	12/10	5,460	10	0.66	14	180	120	9.6	93	7.0	13	3.6	43,000	43,000	43,000
	M.S.	12/19	9,990	5.4	0.50	6	62	50	12.3	99	7.0	13	3.3	43,000	43,000	9,300
	M.S.	12/26	14,300	18	1.0	7	330	128	12.4	102	7.0	8	3.0	24,000	4,300	2,300
		1952														
	M.S.	1/2	14,000	13	1.1	9	155	128	12.2	105	7.0	8	2.9	4,300	910	<360
	M.S.	1/8	12,800	7.9	0.51	8	68	108	11.7	99	7.2	10	3.4	15,000	750	240
	M.S.	1/14	11,400	7.5	0.57	10	63	116	11.5	101	6.8	10	3.3	4,300	1,500	2,300
	M.S.	1/21	5,410	9.4	0.72	11	40	88	10.5	95	7.2	14	4.2	46,000	24,000	15,000
	M.S.	2/11	[illegible]	5.6	0.54	11	63	120	11.0	99	7.4	13	3.2	230	230	430
	M.S.	3/5	[illegible]	[illegible]	2.1	11	440	80	10.9	98	6.9	9	3.5	4,300	2,300	9,300

SAVANNAH RIVER STUDIES

Summary of Individual Results - Sanitary Examinations

Sampling Point		Date	Disch. at Augusta Sec-Ft	O.C. Moore ppm	5-Day 20°C BOD ppm	Temp. °C	Turb. ppm	Color ppm	Dissolved Oxygen ppm	Dissolved Oxygen % Sat	pH	Alkal. ppm	Chloride ppm	Coliforms MPN per 100 ml Ga.	Coliforms MPN per 100 ml	Coliforms MPN per 100 ml S.C.
		1951														
S 203.3	Ga.	8/1	4,440	5.7	0.40	--	54		6.4	--	7.2	20	3.0	2,900		
	M.S.	8/1	4,440	5.1	0.35	--	54	37	6.4	--	7.6	20	5.2		43,000	
	S.C.	8/1	4,440	5.9	0.49	--	52		6.6	--	7.3	20	3.3			24,000
	Ga.	8/14	3,800	4.6	0.49	30	31		6.2	81	7.4	20	3.0	24,000		
	M.S.	8/14	3,800	4.0	0.33	30	31	15	6.0	79	7.3	19	3.2		46,000	
	S.C.	8/14	3,800	5.6	0.40	30	31		5.9	77	7.4	21	3.0			46,000
S 202.9	Ga.	8/30	1,890	3.2	0.30	29	54	20	7.5	97	7.2	18	4.0	2,300		
	M.S.	8/30	1,890	1.7	0.41	29	56	20	7.5	97	7.3	18	3.8		9,300	
	S.C.	8/30	1,890	2.0	0.37	29	47	20	7.4	95	7.3	17	3.4			9,300
	M.S.	9/12	2,080	1.4	0.47	28	<25	10	7.9	100	7.7	19	3.3	24,000	1,500	4,300
	M.S.	10/1	4,800	11	0.42	23	170	48	8.2	95	7.4	17	3.6	24,000	24,000	9,300
	M.S.	10/9	2,560	7.7	0.50	23	75	25	8.2	95	7.3	19	4.0	23,000	23,000	23,000
	M.S.	10/16	2,280	4.5	0.62	20	31	30	8.9	97	7.5	24	4.0	43,000	24,000	15,000
	M.S.	10/31	2,860	5.0	0.70	19	25	19	8.9	95	7.5	22	4.6	240,000	93,000	240,000
	M.S.	12/5	5,550	5.8	0.20	11	28	32	11.1	100	7.1	17	4.3	43,000	43,000	93,000
	M.S.	12/11	6,130	11	0.61	12	150	128	10.2	94	6.7	11	3.2	24,000	24,000	24,000
	M.S.	12/18	9,150	8.3	0.61	7	51	56	11.8	97	7.2	17	3.7	7,500	2,300	24,000
	M.S.	12/27	14,300	16	1.1	6	290	144	12.1	97	6.5	7.0	2.6	15,000	46,000	15,000
		1952														
	M.S.	1/10	11,600	12	0.32	9	100	156	11.3	98	6.8	11	3.0	2,300	9,300	15,000
	M.S.	1/16	8,320	11	0.68	12	52	124	11.0	101	7.2	10	3.2	23,000	23,000	7,500
	M.S.	1/22	5,040	8.0	0.43	11	36	88	11.2	101	6.9	14	3.7	23,000	23,000	4,300
	M.S.	1/29	6,730	8.8	0.92	11	49	94	10.8	97	7.2	14	4.3	43,000	43,000	43,000
	M.S.	2/13	5,080	10	1.1	12	50	112	11.0	101	7.3	15	3.5	9,300	23,000	23,000
	M.S.	3/6	38,600	11	1.4	11	205	112	11	99	7.0	9	3.2	4,300	2,300	1,500
	M.S.	3/14	33,600	11	1.0	12	175	160	10.8	100	7.1	13	3.3	2,300	2,300	930

SAVANNAH RIVER STUDIES

Summary of Individual Results - Sanitary Examinations

Sampling Point	Date	Disch. at Augusta Sec-Ft	O.C. Core ppm	5-Day 20°C BOD ppm	Temp. °C	Turb. ppm	Color ppm	Dissolved Oxygen ppm	Dissolved Oxygen % Sat	pH	Alkal. ppm	Chloride ppm	Coliforms MPN per 100 ml Ga.	Coliforms MPN per 100 ml S.C.
	1951													
* S 202.65; Bu 0.02	8/1		33	7.4	--	61	45	3.2	--	6.6	19	2.9	2,100,000	
	8/14		34	21	29	31	45	2.1	27	6.7	17	3.1	11,000,000	
	8/23		29	10	27	40	35	1.8	22	7.2	28	3.3	9,300,000	
	8/30		32	11	27	31	43	1.0	12	7.3	35	12	2,300,000	
	9/10		17	3.9	23	<25	38	4.2	48	7.1	23	7.3	430,000	
	9/25		33	5.4	24	150	40	4.4	51	6.9	9	4.9	1,500,000	
	10/1		28	9.1	22	93	55	3.7	42	7.0	23	7.3	3,900,000	
	10/9		34	10	20	33	54	3.7	40	7.1	29	10	15,000 000	
	10/16		30	11	19	13	46	4.4	47	7.0	27	9.7	4,300,000	
	10/31		37	12	20	65	46	4.2	46	7.0	23	10	4,300,000	
	12/11		30	15	11	38	80	5.1	46	6.7	16	7.8	2,100,000	
	12/18		24	12	7	29	50	6.9	57	6.9	16	6.7	930,000	
	12/27		22	5.6	9	62	92	5.2	45	6.3	9	8.1	36,000	
	1952													
	1/10		30	9.2	12	45	84	4.0	37	6.7	16	7.9	2,400,000	
	1/16		35	7.4	14	58	50	3.7	36	7.2	14	8.0	430,000	
	1/22		41	12	13	67	58	4.8	45	6.7	14	7.7	2,300,000	
	1/29		26	8.2	11	70	70	5.3	48	6.9	15	8.6	430 000	
	3/13		24	8.9	13	37	56	2.[illegible]	23	6.9	16	7.3	430,000	
	1951													
S 202.65; Bu 2.2 (Butler Creek at Old Savannah Rd. Bridge)	8/9		10	0.27	--	25	50	[illegible]	--	6.4	6.0	5.0	1,500	
	8/14		9.6	0.62	29	<25	50	6.[illegible]	84	6.3	6.2	3.7	9 300	
	8/23		9.0	0.46	27	<25	45	6.8	84	6.3	5.3	3.7	2,100	
	8/30		6.6	0.61	26	<25	48	7.1	86	6.3	5.2	4.0	1,500	
	9/10		8.7	0.41	24	<25	50	7.4	86	6.6	4.2	4.1	2,300	
	9/25		5.8	0.69	22	10	50	6.0	68	6.1	4.3	4.4	2,300	
	10/9		12	0.47	21	6	48	7.7	86	6.3	5.5	7.3	2,300	
	12/27		8.2	0.38	9	2	29	10.7	92	4.9	2.0	3.4	210	

* Butler Creek, 100' before its confluence with the Savannah River at S 202.65

SAVANNAH RIVER STUDIES

Summary of Individual Results - Sanitary Examinations

Sampling Point		Date	Disch. at Augusta Sec-Ft	O C. Moore ppm	5-Day 20°C BOD ppm	Temp. °C	Turb. ppm	Color ppm	Dissolved Oxygen ppm	Dissolved Oxygen % Sat	pH	Alkal. ppm	Chloride ppm	Coliforms MPN per 100 l Ga.	Coliforms MPN per 100 l S.C.
		1952													
S 202.65;		1/24		11	.47	9	2	54	10.1	87	6.0	2.9	3.3		930
Bu 2.2		2/28		8.8	0.85	9	2	36	10.5	91	6.1	3.2	4.6		93
(Cont'd)		4/2		11	0.61	17	2	52	7.6	88	6.1	5.3	4.0		930
		4/10		8.7	0.51	17	1	26	8.4	86	6.0	6.0	4.7		2,300
*S 202.65;		8/9/51		17	2.0	--	<25	15	3.4	--	6.7	20	5.2		430,000
Bu 0.27;		8/14		10	1.5	27	<25	45	4.0	50	6.7	13	4.7		93,000
Be 2.5;		8/23		24	8.9	26	<25	70	1.4	16	6.5	11	3.5		93,000
Ro 3.6		8/30		18	4.6	27	<25	60	1.6	20	6.6	18	7.3		230,000
		9/10		20	4.8	24	<25	50	2.3	27	7.0	18	6.1		39 000
		9/25		26	3.7	22	90	70	5.0	56	6.7	4.8	5.6		240,000
		10/9		16	2.8	20	5	56	5.0	55	6.7	11	6.1		43,000
		12/27		24	8.3	10	8	56	8.8	78	6.2	7.0	6.7		240,000
		1952													
		1/24		36	8.7	9	14	64	8.8	76	6.2	4.5	6.1		43,000
		2/28		29	8.3	10	42	56	8.4	74	6.5	6.8	6.7		93,000
		4/2		30	4.8	17	145	120	6.0	62	6.4	6.9	5.3		460,000
		4/10		32	.9	17	13	80	6.4	66	6.5	12	6.8		430,000
		1951													
S 201.65	Ga.	8/1	4,440	5.0	0.41	--	58		6.9	--	7.3	20	3.0	75 000	
	M.S.	8/1	4 440	5.0	0.57	--	58	40	7.1	--	7.2	18	3.4		93,000
	S.C.	8/1	4,440	4.8	0.46	--	54		7.1	--	7.2	20	3.5		75,000
	Ga.	8/14	800	.4	.65	31	33		.3	97	7.3	19	2.9	24,000	
	M.S.	8/14	3,800	4.2	0.70	31	32	20	7.4	98	7.3	19	2.7		150,000
	S C.	8/14	3,800	3.7	0.[illegible]8	31	32		7.3	98	7.3	19	2.8		43,000
	Ga.	8/29	2,150	3.0	0.48	29	48	25	7.0	90	7.2	18	3.3	93,000	
	M S.	8/29	2,150	2.9	0.47	29	47	25	7.2	92	7.2	17	3.5		240,000
	S C.	8/29	2,150	2.7	0.35	29	51	25	7.3	94	7.2	17	3.2		43,000

* Rocky Creek at Old Savannah Rd. Bridge.

SAVANNAH RIVER STUDIES
Summary of Individual Results - Sanitary Examinations

Sampling Point		Date	Disch. at Augusta Sec-Ft	O.C. Moore ppm	5-Day 20°C BOD ppm	Temp. °C	Turb. ppm	Color ppm	Dissolved Oxygen ppm	Dissolved Oxygen % Sat	pH	Alkal. ppm	Chloride ppm	Coliforms MPN per 100 ml Ga.	Coliforms MPN per 100 ml	Coliforms MPN per 100 ml S.C.
		1951														
S 201.65	M.S.	9/12	2,080	3.5	0.94	28	<25	10	7.9	99	7.6	20	3.3	93,000	93,000	93,000
(Cont'd)	M.S.	10/1	4,800	11	0.29	23	165	45	8.2	94	7.4	18	4.0	93,000	23,000	240,000
	M.S.	12/18	9,150	6.8	0.42	7	50	50	12	96	7.1	13	3.2	24,000	24,000	43,000
		1952														
	M.S.	1/16	8,320	11	0.79	12	48	116	10.7	99	7.0	10	3.7	150,000	460,000	9,300
	M.S.	3/6	38,600	12	1.1	11	200	120	11.0	100	6.8	7.5	3.1	2,300	2,300	3,900
		1951														
*S 198.4;Sp3.7		8/9		12	0.27	--	<25	33	5.9	--	6.4	12	4.6		290	
S 197.0	Ga.	8/1	4,440	6.5	0.94	--	48		7.0	--	7.2	18	3.2	24,000		
	M.S.	8/1	4,440	6.3	0.31	--	48	35	7.0	--	7.2	18	3.5		150,000	
	S.C.	8/1	4,440	4.7	0.52	--	46		7.0	--	7.2	18	3.5			210,000
	Ga.	8/15	4,720	4.9	0.99	30	38		6.8	89	7.4	18	3.5	43,000		
	M.S.	8/15	4,720	4.4	0.44	30	36	15	6.6	86	7.3	18	3.2		43,000	
	S.C.	8/15	4,720	4.5	0.88	30	35		6.9	90	7.3	19	3.5			43,000
	Ga.	8/29	2,150	9.3	0.58	28	59		6.8	86	7.1	18	3.1	240,000		
	M.S.	8/29	2,150	3.8	0.58	28	58	25	6.9	87	7.1	18	3.3		93,000	
	S.C.	8/29	2,150	2.6	0.62	28	58		6.9	87	7.1	18	3.5			39,000
	M.S.	9/13	1,830	4.7	1.0	27	<25	10	7.3	90	7.6	21	3.4	93,000	43,000	150,000
	M.S.	10/1	4,800	11	0.49	23	160	50	7.9	91	7.4	19	4.0	240,000	75,000	75,000
	M.S	10/9	2,560	7.2	0.82	22	78	40	7.8	88	7.2	18	3.6	240,000	240,000	460,000
	M.S.	10/16	2,280	5.3	1.3	20	33	38	8.3	90	7.4	26	4.0		240,000	460,000
	M.S.	10/31	2,860	5.4	0.60	21	27	21	8.5	95	7.5	21	4.7	430,000	75,000	430,000
	M.S.	12/5	5,550	6.6	0.44	11	27	31	10.8	97	7.0	15	3.8	240,000	93,000	43,000
	M.S.	12/11	6,130	11	0.45	13	150	124	9.9	93	6.8	11	3.3	23,000	15,000	43,000
	M.S.	12/18	9,150	6.9	0.73	7	47	50	11.7	96	7.1	13	3.7	24,000	21,000	9,300
	M.S.	12/27	14,300	16	0.94	6	290	152	12.0	96	6.3	6	3.2	24,000	2,300	7,500

* Spirit Creek at Old Savannah Road Bridge.

SAVANNAH RIVER STUDIES

Summary of Individual Results - Sanitary Examinations

Sampling Point		Date	Disch. at Augusta Sec-Ft	O.C. Moore ppm	5-Day 20°C B.O.D ppm	Temp. °C	Turb. ppm	Color ppm	Dissolved Oxygen ppm	Dissolved Oxygen % Sat	pH	Alkal. ppm	Chloride ppm	Coliforms MPN per 100 ml Ga.	Coliforms MPN per 100 ml	Coliforms MPN per 100 ml S.C.
		1952														
S 197.0	M.S.	1/10	11,600	12	0.68	9	96	148	11.2	97	6.8	11	3.1	9,300	9,300	4,300
(Cont'd)	M.S.	1/16	8,320	10	0.67	12	50	108	10.8	100	7.2	11	3.3	15,000	43,000	43,000
	M.S.	1/22	5,040	8.8	0.67	11	41	84	10.5	95	6.9	13	3.8	150,000	75,000	43,000
	M.S.	1/29	6,730	8.1	1.2	11	48	92	10.4	94	7.3	13	4.0	9,300	15,000	15,000
	M.S.	2/13	5,080	9.2	1.0	12	52	112	10.7	99	7.3	14	3.6	43,000	23,000	9,300
	M.S.	3/6	38,600	15	1.5	11	215	120	10.9	98	7.1	9.5	3.2	2,300	930	2,300
		1951														
S 192.0	Ga.	8/2	4,260	5.5	0.51	--	64	38	6.4	--	7.1	20	3.5	430,000		
	S.C.	8/2	4,260	5.7	0.51	--	62		6.4	--	7.0	20	3.6			150,000
	Ga.	8/15	4,720	4.0	0.55	30	38	15	6.7	88	7.2	18	3.3	24,000		
	S.C.	8/15	4,720	5.1	0.54	30	37		6.6	86	7.1	20	3.6			93,000
	Ga.	9/6	2,170	5.0	0.64	29	<25	15	7.0	89	7.4	20	3.3	240,000		
	S.C.	9/6	2,170	4.0	0.46	29	<25		6.9	88	7.5	18	4.0			9,300
	M.S.	9/13	1,830	1.9	0.59	27	<25	10	7.1	88	7.6	20	3.3	75,000		23,000
S 189.0	Ga.	8/2	4,260	5.1	0.59	—	58	33	6.6	--	7.0	20	3.6	430,000		
	S.C.	8/2	4,260	4.4	0.35	--	56		6.3	--	7.2	21	3.6			930,000
S 187.0	Ga.	8/16	3,670	5.9	0.51	29	29	15	6.6	85	7.4	18	3.2	93,000		
	S.C.	8/16	3,670	6.2	0.71	29	26		6.6	85	7.3	18	3.5			93,000
	M.S.	9/6	2,170	3.9	1.7	29	<25	15	6.9	89	7.5	18	3.5		23,000	
	M.S.	9/13	1,830	7.0	0.54	27	<25	10	7.0	87	7.7	19	3.5	75,000		93,000
S 182.0	Ga.	8/2	4,260	3.9	0.31	—	57	30	6.4	--	7.0	20	3.3	43,000		
	S.C	8/2	4,260	4.7	0.38	--	55		6.5	—	7.2	19	3.5			15,000
	Ga.	8/16	3,670	7.0	0.44	29	29	15	6.1	79	7.3	18	3.6	24,000		
	S.C.	8/16	3,670	5.4	0.87	29	28		6.6	85	7.4	18	3.3			21,000
	M.S.	9/6	2,170	1.6	0.52	29	25	15	6.7	86	7.6	18	3.6		9,300	

SAVANNAH RIVER STUDIES

Summary of Individual Results - Sanitary Examinations

Sampling Point		Date	Disch. at Augusta Sec-Ft	O.C. Moore ppm	5-Day 20°C BOD ppm	Temp. °C	Turb. ppm	Color ppm	Dissolved Oxygen ppm	Dissolved Oxygen % Sat	pH	Alkal. ppm	Chloride ppm	Coliforms MPN per 100 ml Ga.	Coliforms MPN per 100 ml S.C.
		1951													
S 177.0	M.S.	8/2	4,260	4.3	0.36	--	49	30	6.5	--	6.9	21	3.4	24,000	
	Ga.	8/16	3,670	10.7	0.62	29	29	15	6.5	84	7.4	18	3.4	4,300	
	S.C.	8/16	3,670	5.0	0.78	29	27		6.8	87	7.3	18	3.4		24,000
	Ga.	9/6	2,170	1.8	0.75	29	<25	15	6.9	88	7.5	18	3.5	15,000	
	S.C.	9/6	2,170	2.1	0.76	29	26		7.0	90	7.6	19	3.5		>110,000
	M.S.	9/13	1,830	3.2	0.51	27	<25	10	7.0	87	7.6	19	3.4	24,000	9,300
*S176.67; BG 1.9		8/30		6.0	2.4	27	<25	25	6.4	79	7.4	42	4.0		2,300
		9/10		8.6	0.54	24	<25	30	6.7	79	7.4	38	3.6		24,000
		9/18		21	0.66	22	<25	57	6.2	71	7.5	25	3.9		4,300
S 172.0	M.S.	8/2	4,260	4.4	0.28	--	49	30	6.2	--	7.2	20	3.3		93,000
	Ga.	8/16	3,670	5.0	0.68	30	30	15	6.8	90	7.4	18	3.6	46,000	
	S.C.	8/16	3,670	5.0	0.56	30	29		6.6	87	7.4	18	3.5		15,000
	Ga.	9/10	2,940	9.5	1.1	27	33	10	7.5	93	7.5	21	3.8	23,000	
	S.C.	9/10	2,940	7.6	1.2	27	29	10	7.6	94	7.5	19	3.8		43,000
	M.S.	9/13	1,830	2.0	0.55	27	<25	10	7.2	89	7.7	18	3.5	9,300	39,000
	M.S.	10/3	3,350	6.6	0.55	23	195	35	7.4	85	7.3	16	3.8	240,000	93,000
	M.S.	10/10	2,680	8.3	0.44	21	76	30	7.6	84	7.4	18	3.6	93,000	93,000
	M.S.	10/23	1,890	5.3	0.44	21	27	20	7.6	85	7.3	21	4.8	9,300	93,000
	M.S.	11/7	4,260	6.9	0.59	13	49	30	9.4	89	7.7	81	3.9	43,000	23,000
	M.S.	12/5	5,550	5.0	0.55	12	33	35	10.4	96	7.1	17	4.1	93,000	210,000
	M.S.	12/20	8,420	6.9	0.89	6	87	52	11.9	95	7.0	15	3.6	24,000	3,900
	M.S.	12/28	14,200	16	1.0	6	245	96	12.0	96	6.6	7	2.9	2,300	2,300
		1952													
	M.S.	1/3	13,900	15	0.91	10	160	148	11.5	102	6.9	8	3.4	280	4,300
	M.S.	1/9	12,800	9.9	0.53	9	88	96	11.3	98	6.9	8	3.2	4,300	750

* Boggy Gut Creek at River Road Bridge.

SAVANNAH RIVER STUDIES

Summary of Individual Results - Sanitary Examinations

Sampling Point		Date	Disch. at Augusta Sec-Ft	O.C. Moore ppm	5-Day 20°C BOD ppm	Temp. °C	Turb. ppm	Color ppm	Dissolved Oxygen ppm	Dissolved Oxygen % Sat	pH	Alkal. ppm	Chloride ppm	Coliforms MPN per 100 ml Ga.	Coliforms MPN per 100 ml S.C.
		1952													
S 172.0	M.S.	1/15	13,200	9.5	0.65	11	90	100	11.0	99	7.1	12	3.3	4,300	2,300
(Cont'd)	M.S.	1/23	5,030	9.2	0.87	11	61	84	10.4	94	6.9	14	3.7	93,000	120,000
	M.S.	2/18	6,030	13	0.86	10	45	113	10.7	95	7.0	15	4.1	15,000	2,100
	M.S.	4/3	33,200	10	0.92	14	130	240	8.6	82	6.9	11	3.1	2,300	4,300
		1951													
S 171.59;		8/16		22	0.97	24	<25	55	6.9	80	6.5	7.7	3.3	9,300	
UTR 0.01		9/10		5.5	0.12	20	<25	20	8.5	93	6.7	5.4	3.3	430	
		9/13		4.0	0.06	25	<25	20	8.0	95	7.0	7.1	3.2	1,500	
		10/3		5.1	0.34	21	4	30	8.1	90	6.7	8.0	3.9	2,300	
		10/10		5.1	0.61	16	2	22	9.1	91	6.7	7.1	3.0	930	
		10/23		13	0.47	19	3	44	7.8	84	6.7	8.9	5.8	2,100	
		11/7		13	0.67	13	2	56	8.6	82	6.5	6.1	3.6	930	
		12/5		14	1.1	14	2	66	8.3	80	6.4	6.0	3.9	1,500	
		12/20		12	0.73	7	3	56	10.5	86	5.7	4.0	3.5	4,300	
		12/28		11	0.74	9	8	72	7.9	68	6.1	5.0	3.3	930	
		1952													
		1/3		10	0.48	16	2	52	7.1	71	6.6	6.0	3.5	91	
		1/9		9.9	0.65	11	1	44	8.8	79	6.3	5.0	3.0	240	
		1/23	Disch. at Bur-	15	0.61	13	5	64	8.9	84	5.5	3.5	3.4	9,300	
		2/18	tons Fy.	16	1.7	10	1	70	10.1	89	6.2	4.7	3.7	930	
		1951	Sec-Ft												
S 167.0	M.S.	8/2	5,290	8.1	0.33	--	45	25	6.4	--	7.2	20	3.5	24,000	
	Ga.	8/16	4,930	5.1	0.51	29	32 }	20	6.6	84	7.3	18	3.4	9,300	
	S.C.	8/16	4,930	5.0	0.43	29	31 }		6.5	84	7.4	18	3.3		9,300
	Ga.	9/10	2,210	6.1	1.3	27	27	10	7.7	96	7.5	19	3.6	23,000	
	S.C.	9/10	2,210	6.7	1.4	27	26	10	7.7	96	7.5	19	3.8		23,000
	M.S.	9/13	2,800	3.4	0.29	27	<25	10	7.1	87	7.6	17	3.3	15,000	4,300

SAVANNAH RIVER STUDIES

Summary of Individual Results - Sanitary Examinations

Sampling Point		Date	Disch. at Burtons Sec-Ft	O.C. Moore ppm	5-Day 20°C BOD ppm	Temp. °C	Turb. ppm	Color ppm	Dissolved Oxygen ppm	Dissolved Oxygen % Sat	pH	Alkal. ppm	Chloride ppm	Coliforms MPN per 100 ml Ga.	Coliforms MPN per 100 ml S.C.
		1951													
*S 164.26;		8/20		6.9	0.32	27	<25	35	5.7	70	7.0	15	3.5	930	
Fo 0.01		9/4		6.0	0.25	27	<25	25	6.1	76	7.0	14	3.9	430	
		9/17		31	1.6	22	220	56	5.1	57	6.5	5.9	3.4	4,300	
		10/3		7.5	0.42	21	7	50	6.7	74	6.9	13	4.3	230	
		10/10		9.8	0.32	18	12	44	7.2	76	6.9	13	3.9	2,300	
		10/23		12	1.3	20	26	38	6.2	67	6.9	13	5.6	1,500	
		11/7		21	0.77	12	9	74	7.7	71	6.7	8.9	4.7	2,300	
		12/5		10	0.56	13	2	43	7.5	71	6.4	8.3	3.7	430	
		12/20		14	0.88	6	3	58	10.3	82	6.6	12	4.5	430	
		1952													
		1/23		9.4	0.73	13	4	72	8.2	78	6.7	11	4.1	930	
		2/18		14	0.62	10	13	110	9.3	82	6.6	8.2	4.0	430	
		1951													
S 162.0	Ga.	8/6	4,480	7.7	0.26	21	58	25	6.0	—	7.2	20	3.3	15,000	
	S.C.	8/6	4,480	6.9	0.39	21	54		6.1	—	7.1	19	3.3		110,000
	Ga.	8/20	4,480	4.0	0.42	31	41	15	6.4	86	7.3	18	3.3	39,000	
	S.C.	8/20	4,480	5.4	0.77	31	42		6.7	90	7.3	18	3.4		9,300
	Ga.	9/4	2,720	5.4	0.76	29	38	15	7.1	91	7.3	18	3.8	43,000	
	S.C.	9/4	2,720	8.4	0.55	29	40	15	7.0	91	7.4	17	3.6		23,000
	Ga.	9/17	4,300	15	0.89	24	43	35	6.4	75	7.3	16	4.1	93,000	
	S.C.	9/17	4,300	15	1.0	24	42	35	6.5	77	7.3	15	3.2		75,000
S 157.0	Ga.	8/6	4,480	6.8	0.52	—	56	38	6.2	—	7.1	19	3.2	46,000	
	S.C.	8/6	4,480	7.8	0.27	—	60		6.2	—	7.2	19	3.0		46,000
	M.S.	8/20	4,480	4.9	0.45	31	39	15	6.5	87	7.3	18	3.6	7,500	
	M.S.	9/4	2,720	4.7	0.76	29	40	15	7.0	91	7.3	17	3.9	43,000	
	M.S.	9/17	4,300	15	0.62	24	45	35	6.2	73	7.4	16	3.4	93,000	

* Fourmile Branch, 0.01 mile above confluence.

SAVANNAH RIVER STUDIES

Summary of Individual Results - Sanitary Examinations

Sampling Point		Date	Disch. at Burtons Fy. Sec-Ft	O.C. Moore ppm	5-Day 20°C BOD ppm	Temp. °C	Turb. ppm	Color ppm	Dissolved Oxygen ppm	Dissolved Oxygen % Sat	pH	Alkal. ppm	Chloride ppm	Coliforms MPN per 100 ml Ga.	Coliforms MPN per 100 ml S.C.
		1951													
*S 155.2;		8/20		5.1	0.50	27	<25	25	5.8	72	7.3	18	3.4		4,300
St 0.01		9/4		6.9	0.44	26	<25	25	6.8	82	7.5	35	4.1		4,300
		9/18		16	2.6	21	<25	48	7.9	88	7.6	25	4.6		2,300
		9/25		12	0.84	22	8	40	7.3	83	7.6	26	4.5		7,500
		10/3		5.1	0.31	21	7	30	6.6	74	7.5	33	4.4		930
		10/10		6.1	0.52	21	12	24	8.8	97	7.5	32	3.6		210
		10/23		23	1.2	21	8	72	6.7	74	7.2	21	8.1		930
		11/7		14	0.57	14	5	44	7.7	74	7.0	22	5.8		430
		12/3		18	0.93	11	13	78	8.6	78	6.7	15	5.0		1,500
		12/20		21	0.85	5	7	112	9.3	73	6.5	13	5.3		2,400
		1952													
		1/23		22	0.80	12	3	172	6.8	63	6.9	13	4.6		1,500
		2/6		16	0.65	10	3	160	7.3	64	7.0	14	5.0		430
		2/18		20	0.79	9	3	150	8.5	73	6.8	13	4.5		930
		1951													
S 152.0	Ga.	8.6	4,480	5.8	0.39	—	58	40	6.4	--	7.2	19	3.5	46,000	
	S.C.	8/6	4,480	6.1	0.53	--	56		6.4	--	7.2	19	3.2		46,000
	M.S.	8/20	4,480	3.5	0.70	31	38	15	6.6	88	7.4	18	3.3		4,300
	M.S.	9/4	2,720	8.2	0.79	29	46	15	7.2	92	7.3	19	4.1		15,000
	Ga.	9/17	4,300	12	0.92	24	60	30	6.5	77	7.4	16	3.5	9,300	
	S.C.	9/17	4,300	14	0.93	24	56	30	6.6	78	7.4	16	3.5		23,000
	M.S.	10/3	5,560	8.1	0.49	23	155	40	7.3	84	7.4	18	3.7	75,000	23,000
	M.S.	10/10	3,230	7.2	0.32	21	82	29	7.8	86	7.3	16	3.9	43,000	43,000
	M.S.	10/23	2,640	6.2	0.57	21	24	25	7.8	87	7.4	23	5.2	24,000	15,000
	M.S.	11/7	6,280	6.0	0.39	14	29	33	9.3	90	7.2	18	3.9	9,300	43,000
	M.S.	12/3	4,120	6.7	0.50	11	27	36	10.3	93	7.1	17	3.8	15,000	15,000
	M.S.	12/20	9,300	7.0	0.78	6	64	44	11.6	93	7.0	16	4.0	93,000	24,000

* Steel Creek, 50 ft. above confluence.

SAVANNAH RIVER STUDIES

Summary of Individual Results - Sanitary Examinations

Sampling Point		Date	Disch. at Burtons Fy. Sec-Ft	O.C. Moore ppm	5-Day 20°C BOD ppm	Temp. °C	Turb. ppm	Color ppm	Dissolved Oxygen ppm	Dissolved Oxygen % Sat	pH	Alkal. ppm	Chloride ppm	Coliforms MPN per 100 ml Ga.	Coliforms MPN per 100 ml S.C.
		1952													
S 152.0	N.S.	1/3	12,800	13	0.68	10	165	144	11.4	100	7.0	7	3.4	9,300	930
(Cont'd)	N.S.	1/9	12,400	11	0.69	12	90	108	11.2	103	7.0	9	3.7	4,300	15,000
	N.S.	1/15	10,900	10	0.66	11	75	104	10.8	98	7.0	12	3.8	9,300	9,300
	N.S.	1/23	6,550	9.3	0.38	11	53	88	9.7	88	6.9	13	4.0	15,000	23,000
	N.S.	2/6	9,200	10	0.82	11	80	120	10.0	90	7.2	13	4.6	9,300	43,000
	N.S.	2/18	8,330	10	1.4	11	42	100	10.3	93	7.0	15	4.1	9,300	23,000
	N.S.	4/3	33,000	8.2	0.46	15	95	230	8.1	80	7.0	11	3.2	750	2,300
		1951													
S 142.0	N.S.	8/6	4,480	5.3	0.40	--	59	32	6.4	--	7.2	19	3.2	9,300	
	N.S.	8/20	4,480	4.4	0.52	31	37	15	6.6	88	7.3	18	3.3	4,300	
	N.S.	9/4	2,720	4.1	0.89	29	49	15	7.3	94	7.2	18	4.1	24,000	
	N.S.	9/17	4,300	12	0.73	24	61	25	6.7	79	7.3	17	3.4	9,300	
*S 137.32;		8/21		9.5	0.40	24	<25	20	7.0	82	7.4	48	2.7	360	
LTR 0.01		9/18		19	0.54	21	<25	40	7.6	94	7.8	41	4.1	11,000	
		9/25		31	1.4	22	7	80	6.2	70	7.4	26	4.9	2,300	
		10/4		4.7	0.21	20	2	25	7.7	84	8.0	47	3.9	2,300	
		10/11		7.2	0.20	16	1	19	8.8	94	7.8	48	4.2	2,300	
		10/18		6.7	0.19	17	2	18	8.2	84	7.7	47	4.0	430	
		10/25		21	0.76	20	2	55	6.6	72	7.4	37	3.3	2,400	
		11/1		17	0.61	20	2	48	6.6	72	7.6	42	5.2	2,100	
		12/3		9.8	0.59	11	2	26	6.8	61	7.5	54	4.8	430	
		1952													
		1/4		14	0.37	14	1	54	8.2	79	7.6	36	4.2	430	
		1/9		12	0.31	11	1	38	9.7	88	7.3	34	3.8	240	
		2/6		21	1.3	10	2	88	10.1	89	7.4	25	4.6	230	
		3/13		21	0.69	19	2	80	7.7	82	7.2	13	4.3	430	

* Lower Three Runs, 50 ft. above confluence.

SAVANNAH RIVER STUDIES

Summary of Individual Results - Sanitary Examinations

Sampling Point		Date	Disch. at Burtons Fy. Sec-Ft	O.C. Moore ppm	5-Day 20°C BOD ppm	Temp. °C	Turb. ppm	Color ppm	Dissolved Oxygen ppm	Dissolved Oxygen % Sat	pH	Alkal. ppm	Chloride ppm	Coliforms MPN per 100 ml Ga.	Coliforms MPN per 100 ml S.C.
		1951													
S 132.0	M.S.	8/6	4,480	5.3	0.25	--	58	37	6.4	—	7.3	19	3.5	9,300	
		1952													
(1) S129.25	M.S.	1/4	13,100	12	0.94	10	160	132	11.0	97	7.0	8.6	3.0	3,900	
	M.S.	1/9	12,400	14	0.52	11	125	136	11.3	102	6.9	0.71	3.4	9,300	
	M.S.	2/6	9,200	12	1.51	11	83	100	10.0	90	7.2	14	4.2	9,300	
	M.S.	3/13	34,400	11	0.91	14	92	160	8.3	80	6.9	13	3.2	430	
		1951													
S 122.0	M.S.	8/6	4,480	4.8	0.85	—	59	35	6.6	--	7.2	19	3.4	7,500	
	M.S.	8/21	4,660	8.1	0.34	29	36	15	6.9	88	7.4	21	3.2	4,300	
	M.S.	9/5	3,140	5.8	0.66	29	43	15	7.0	90	7.5	20	4.1	3,900	
	M.S.	9/19	4,840	8.8	0.29	23	65	30	6.8	78	7.3	17	3.5	9,300	
S 112.0	M.S.	8/8	4,480	4.9	0.60	—	53	15	6.7	--	7.3	20	3.5	1,100,000	
	M.S.	8/21	4,660	7.5	0.62	30	34	15	6.9	90	7.4	20	3.2	3,900	
	M.S.	9/5	3,140	5.2	0.69	29	47	15	7.3	93	7.5	21	3.9	9,300	
	M.S.	9/19	4,840	6.6	0.39	23	56	30	6.8	79	7.3	17	3.8	4,300	
(2) S 105.0; Br 4.0		8/9		5.5	0.24	27	<25	30	7.0	86	7.5	42	3.2	430	
(3) S 105.0; Br 0.5		8/21		8.1	1.5	32	48	15	4.1	56	7.1	23	3.4	36	
		9/5		5.6	0.21	26	<25	20	7.5	92	7.7	39	3.6	930	
		9/19		6.9	0.15	21	<25	30	7.5	84	7.6	34	4.1	930	
(4) S 105.0; Bl 1.2		8.9		<0.10	0.06	19	<25	< 5	5.1	55	7.6	113	4.7	36	

(1) Bridge on Ga. Highway 301, known as Burtons Ferry Bridge.
(2) Brier Creek at Brannons Bridge.
(3) Brier Creek 0.5 mile above confluence.
(4) Blue Springs flows into Beaverdam Creek.

SAVANNAH RIVER STUDIES

Summary of Individual Results - Sanitary Examinations

Sampling Point		Date	Disch. at Burtons Fy. Sec-Ft	O.C. Moore ppm	5-Day 20°C BOD ppm	Temp. °C	Turb. ppm	Color ppm	Dissolved Oxygen ppm	Dissolved Oxygen % Sat	pH	Alkal. ppm	Chloride ppm	Coliforms MPN per 100 ml Ga.	Coliforms MPN per 100 ml S.C.
		1951													
S 102.0	M.S.	8/8	4,480	6.4	0.54	—	51	15	6.8	—	7.3	20	3.3	24,000	
	M.S.	8/21	4,660	10.9	0.96	30	33	20	7.1	93	7.2	20	2.8	360	
	M.S.	9/5	3,140	5.2	0.73	29	44	15	7.2	93	7.6	21	4.0	4,300	
	M.S.	9/19	4,840	11	0.30	23	53	30	6.7	77	7.4	18	3.8	9,300	
			Disch. near Clyo Sec-Ft												
S 92.0	M.S.	8/8	4,950	7.2	0.21	--	53	15	6.4	--	7.3	20	3.2	9,300	
	M.S.	8/21	5,040	9.8	0.79	29	33	20	6.9	89	7.3	20	2.8	910	
	M.S.	9/5	3,210	11	0.61	29	46	15	7.1	91	7.6	22	3.8	4,300	
	M.S.	9/19	4,770	9.1	0.47	23	52	30	6.9	80	7.5	18	3.5	9,300	
S 82.0	M.S.	8/8	4,950	4.3	0.04	—	55	15	6.5	—	7.3	20	3.4	9,300	
S 72.0	M.S.	8/8	4,950	4.0	0.46	—	54	15	6.7	—	7.4	20	3.3	15,000	
	M.S.	8/21	5,040	9.9	1.0	30	38	20	7.3	95	7.3	21	3.3	1,500	
	M.S.	9/5	3,210	9.2	0.72	29	57	15	7.3	94	7.6	25	3.7	930	
	M.S.	9/19	4,770	8.4	0.49	23	60	20	7.3	84	7.5	21	3.6	1,500	
S 62.0	M.S.	8/8	4,950	6.8	0.43	21	54	15	6.8	—	7.4	20	3.4	15,000	
S 52.0	M.S.	8/8	4,950	7.6	0.26	—	55	15	6.6	—	7.4	21	3.4	910	
	M.S.	8/21	5,040	8.3	0.64	30	40	20	6.9	91	7.3	21	3.3	1,500	
	M.S.	9/5	3,210	4.9	0.36	29	51	15	7.2	93	7.7	25	3.9	4,300	
	M.S.	9/19	4,770	5.3	0.24	23	50	15	7.4	85	7.6	23	3.7	930	
	M.S.	10/4	6,260	8.8	0.31	26	122	34	7.1	87	7.6	19	8.5	24,000	9,300
	M.S.	10/11	3,870	8.0	0.13	21	108	33	7.8	87	7.5	23	4.2	9,300	24,000
	M.S.	10/18	3,780	16	0.05	21	74	24	8.3	92	7.6	25	34	1,500	2,400
	M.S.	10/25	3,140	8.8	0.37	23	52	20	8.2	94	7.5	25	9.3	9,300	46,000
	M.S.	11/1	4,770	12	0.31	21	52	26	8.1	90	7.6	23	28	46,000	9,300

SAVANNAH RIVER STUDIES
Summary of Individual Results - Sanitary Examinations

Sampling Point		Date	Disch. near Clyo Sec-Ft	O.C. Moore ppm	5-Day 20°C BOD ppm	Temp. °C	Turb. ppm	Color ppm	Dissolved Oxygen ppm	Dissolved Oxygen % Sat	pH	Alkal. ppm	Chloride ppm	Coliforms MPN per 100 ml Ga.	Coliforms MPN per 100 ml	Coliforms MPN per 100 ml S.C.
		1951														
S 52.0	M.S.	12/6	5,220	9.4	0.56	14	32	37	9.8	95	7.4	21	5.0	930		750
(Cont'd)		1952														
	M.S.	1/31	7,820	9.8	0.61	10	60	80	9.8	86	6.9	20	4.6	4,300		24,000
	M.S.	2/20	11,200	17	1.9	11	49	96	9.6	87	7.1	14	16	4,300		4,300
	M.S.	3/12	21,400	20	0.97	14	75	160	7.8	75	7.1	14	5.2	750	430	750
	M.S.	4/9	36,500	14	0.67	16	55	160	8.1	81	7.1	17	3.9	430	430	93
		1951														
S 48.2; Eb 10.0(1)		8/9		71	1.8	26	<25	275	4.8	58	5.7	10	5.6		9,300	
S 48.2; Eb 4.3(2)		8/9		77	1.9	26	<25	300	3.2	39	5.6	10	5.6		2,300	
S 48.2; Eb 0.25(3)		8/21		87	1.2	29	<25	300	2.1	27	5.2	9	2.6		730	
		9/5		22	0.69	31	64	100	4.8	64	7.3	20	3.6			
		9/19		6.9	0.62	21	31	35	6.9	76	7.4	22	3.3		430	
		10/4		49	0.81	24	12	132	2.4	28	7.2	15	32		930	
		1952														
		1/31		52	0.87	10	2	230	3.0	26	5.0	6.4	7.9		43	
		2/20		68	2.2	13	2	300	5.5	52	5.6	4.9	6.8		2,400	
S 42.0	M.S.	8/8	4,950	7.5	0.25	22	53	15	6.5	—	7.4	22	3.4		910	
S 32.0	M.S.	8/8	4,950	6.3	0.42	—	48	18	6.5	—	7.4	22	3.5		910	
	M.S.	8/21	5,040	8.7	1.09	31	32	30	6.9	92	7.2	22	3.3		430	

(1) Ebenezer Creek at bridge on Ga. Highway 119.
(2) Ebenezer Creek at bridge on road nearest Savannah River.
(3) Ebenezer Creek, 0.25 mile above confluence (boat sampling).

SAVANNAH RIVER STUDIES
Summary of Individual Results - Sanitary Examinations

Sampling Point		Date	Disch. near Clyo Sec-Ft	O.C. Moore ppm	5-Day 20°C BOD ppm	Temp. °C	Turb. ppm	Color ppm	Dissolved Oxygen ppm	Dissolved Oxygen % Sat	pH	Alkal. ppm	Chloride ppm	Coliforms MPN per 100 ml Ga.	Coliforms MPN per 100 ml S.C.
		1951													
S 11.0	Ga.	10/4	5,310		0.69	25	49	15	4.0	51	8.0	67	7,890	7,500	
	M.S.	10/4	5,310		0.58	25	46	15	3.8	50	8.0	67	7,710		23,000
	S.C.	10/4	5,310		0.56	25	50	15	3.6	46	8.0	67	7,450		4,300
	Ga.	10/11	3,780		1.0	23	74	19	0.0	0	7.6	47	3,040	43,000	
	M.S.	10/11	3,780		1.1	23	70	18	0.0	0	7.6	46	2,890		43,000
	S.C.	10/11	3,780		1.3	23	73	19	0.68	8	7.6	46	3,040		43,000
	Ga.	10/18	3,290		0.51	21	31	11	5.1	63	7.6	80	10,000	4,300	
	M.S.	10/18	3,290		1.0	21	33	12	5.1	62	7.6	79	9,850		2,300
	S.C.	10/18	3,290		0.53	21	31	13	5.1	62	7.6	78	9,680		730
	Ga.	10/25	3,210		1.0	23	14	17	3.7	45	7.2	52	4,190	24,000	
	M.S.	10/25	3,210		1.0	23	15	17	4.4	53	7.2	51	3,980		15,000
	S.C.	10/25	3,210		0.98	23	14	19	4.0	48	7.2	51	3,810		2,400
	Ga.	11/1	4,680		1.2	23	65	13	2.7	34	7.7	77	7,680	2,400	
	M.S.	11/1	4,680		0.86	23	85	14	3.1	39	7.7	79	8,110		2,400
	S.C.	11/1	4,680		1.3	23	260	14	2.8	34	7.7	81	8,320		4,600
	M.S.	12/6	6,760		0.82	14	126	13	2.8	27	7.5	50	2,720	4,300	4,300
		1952													9,300
	M.S.	1/4	14,500		0.78	12	120	28	6.3	58	7.4	26	1,620	21,000	43,000
	M.S.	2/20	9,900		1.2	13	46	32	6.8	67	7.4	37	3,220	23,000	23,000
	M.S.	3/12	38,600		1.1	15	170	32	6.2	61	7.6	29	2,490	9,300	23,000
	M.S.	4/9	36,500		2.8	17	190	220	6.9	71	7.2	19	13	4,300	4,300	9,300

APPENDIX "B"

SUMMARY OF INDIVIDUAL RESULTS

MINERAL EXAMINATIONS

SAVANNAH RIVER STUDIES

Summary of Individual Results - Mineral Examinations

(Results in ppm)

Station	Date 1951 1952	Suspended Solids Total	Suspended Solids Ash	Silica SiO_2	Sulfate SO_4	Magnesium Mg	Sod. + Pot. Na+K	Total Dis. Solids	Iron Fe	Fluoride F	Nitrate NO_3	Manganese Mn	Ortho phos. PO_4	Total phos. PO_4	Calcium Ca	Bicarb. HCO_3	Chloride Cl	Iron Al. Oxides Fe+Al Oxides	Aluminum Al
S 218.5	12/10	94.4	66.4	27.0	6.2	1.4	3.0	62.4	*4.4	0.05	0.65	nil	0.08	0.25	2.7	13	3.6	24.5	9.5
	1/8	34.0	25.2	23.2	3.6	1.4	3.9	74.8	3.6	0.10	0.10	0.03	0.02	0.18	2.6	11	3.2	17.0	6.2
S 202.9	10/31	19.6	12.0	15.3	3.1	1.1	4.4	54.4	0.02	0.15	0.15	nil	0.01	0.40	2.8	22	4.6	3.3	1.6
	12/18	26.0	12.8	16.9	4.9	1.7	3.7	48.4	*0.80	0.18	0.80	nil	0.07	0.20	3.2	17	3.7	5.0	2.0
	1/29	30.0	22.0	19.6	2.9	1.2	3.4	64.4	2.2	0.20	1.2	0.003	0.01	0.02	4.3	14	4.3	9.2	3.2
	2/13	30.4	20.4	21.4	3.4	1.0	3.1	79.2	3.0	0.15	1.6	0.03	0.01	0.12	4.3	15	3.5	13.3	4.7
	3/13	108	89.2	7.2	10.2	0.93	4.5	28.0	0.15	nil	0.16	0.009	0.02	0.02	3.7	13	3.3	1.2	0.49
S 197	10/31	19.0	11.4	14.5	2.9	1.2	4.2	54	0.02	0.15	0.01	nil	0.13	0.40	3.0	21	4.7	2.9	1.4
	12/18	22.4	11.6	16.5	4.2	1.6	3.8	51.2	0.95	0.17	0.80	nil	0.07	0.60	3.1	13	3.7	5.3	1.8
	1/29	28.8	21.2	19.3	3.3	1.1	3.2	64.8	2.6	0.20	1.2	0.004	0.01	0.12	4.4	13	4.0	11.9	4.2
	2/13	36.4	26.4	21.9	3.6	1.2	3.8	72.4	2.8	0.15	1.6	0.04	0.06	0.17	4.3	16	3.6	14.9	5.7
S 172	10/23	20.4	14.8	10.3	7.2	0.26	8.4	56	0.02	0.15	0.20	nil	0.05	0.40	4.2	21	4.8	1.8	0.80
	12/28	124	106	23.6	4.0	1.6	3.8	126	3.8	0.10	2.8	0.04	0.02	0.18	2.6	7.2	2.9	20.8	8.1
	1/15	48.4	40.8	19.7	4.1	1.2	4.4	72.8	2.8	0.10	1.3	0.013	0.04	0.12	2.7	12	3.3	13.6	5.1
	4/3	64.8	51.2	7.8	4.8	0.94	1.1	44.4	0.56	—	0.24	0.008	0.01	0.04	3.2	11	3.1	0.98	0.08
S 171.59; UTR 0.01	10/23	5.8	1.8	7.4	1.6	0.24	5.9	40	0.02	0.15	0.07	nil	0.07	0.28	2.3	8.9	5.8	0.5	0.14
	12/28	4.8	3.6	12.5	3.6	1.5	1.8	56.8	0.85	nil	2.4	0.001	0.10	0.16	2.6	4.9	3.3	5.4	2.1
	1/23	5.6	3.6	9.6	2.1	0.80	5.0	24.8	1.2	0.15	1.2	0.003	0.12	0.14	2.5	3.5	3.4	2.8	0.53
S 164.26; Fo 0.01	11/7	10.8	4.4	9.8	2.8	1.2	5.7	60.4	0.005	0.15	0.04	nil	0.007	0.16	2.9	8.9	4.7	5.3	2.7
	1/23	1.6	nil	8.7	1.4	1.2	0.54	36.8	0.24	0.15	0.80	0.004	0.09	0.12	3.7	11	4.1	2.7	1.2
	2/18	16.0	8.0	11.7	2.1	0.58	1.7	44.4	3.5	nil	0.52	0.03	0.05	0.10	3.7	8.2	4.0	9.0	2.0

* Fusion

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SAVANNAH RIVER STUDIES

Summary of Individual Results Mineral Examinations

(Results in ppm)

Station	Date 1951 1952	Suspended Solids Total	Suspended Solids Ash	Silica SiO_2	Sulfate SO_4	Magnesium Mg	Sod. + Pot. Na+K	Total Dis. Solids	Iron Fe	Fluoride F	Nitrate NO_3	Manganese Mn	Ortho phos. PO_4	Total phos. PO_4	Calcium Ca	Bicarb. HCO_3	Chloride Cl	Iron Al. Oxides Fe+Al Oxides	Aluminum Al
S 155.2; St 0.01	11/7	9.6	2.8	10.5	3.3	1.1	7.1	60	0.015	0.13	0.03	nil	0.03	0.28	8.1	22	5.8	2.0	0.93
	2/6	5.6	2.8	11.6	3.3	0.78	1.6	134	3.4	0.15	0.56	0.003	0.02	0.02	6.5	14	5.0	6.0	0.63
S 152	12/3	16.0	10.4	13.4	3.4	1.4	2.2	48.8	0.003	0.15	1.1	nil	0.07	0.14	3.2	17	3.8	2.1	1.0
	1/9	50.8	42.0	21.8	4.4	1.3	4.5	62.4	2.9	0.10	1.2	0.003	0.04	0.18	2.6	9.2	3.7	15.2	5.8
	4/3	42.8	34.0	7.2	5.1	1.3	0.73	34.8	0.69	0.05	0.24	0.01	0.01	0.03	3.2	11	3.1	1.4	0.18
S 140.9; LTR 5.75	12/3	3.2	nil	14.8	4.6	1.7	4.2	87.2	0.013	0.12	1.2	nil	0.04	0.14	17.1	54	4.8	0.50	0.20
	2/6	0.40	nil	12.4	2.1	0.71	0.77	128	0.46	0.14	0.96	0.003	0.005	0.06	14.5	25	4.6	2.1	0.73
S 132	1/4	102	80.8	19.1	4.3	1.2	3.6	65.2	2.9	0.15	0.90	0.034	0.02	0.24	2.5	8.6	3.0	14.7	5.5
S 129.25	3/13	37.2	26.0	7.6	11.9	0.88	5.5	32.8	0.65	0.05	0.20	0.007	0.01	0.01	4.2	13	3.2	1.7	0.40
S 52	12/6	15.6	10.4	13.6	6.3	1.6	3.7	29.2	0.003	nil	1.4	nil	0.04	0.04	5.1	21	5.0	3.9	2.0
	2/20	34.0	25.6	17.6	4.0	1.0	2.5	74.0	2.2	0.10	0.28	0.02	0.03	0.11	5.6	14	16.2	9.3	3.2
	4/9	26.8	21.6	—	5.7	0.83	—	30.4	0.08	0.02	0.07	0.007	0.01	0.03	4.1	17	3.9	0.40	0.14
S 11	12/6	34.8	27.6	8.3	254.	164.	659.	3632.	0.28*	0.23	0.10	0.025	0.01	0.04	64	50	2720.	8.3	4.2
	1/4	72.8	52.8	11.9	212.	75.4	713.	2981.	0.18	0.10	1.3	0.005	0.05	0.15	52	26	1620.	4.7	2.3
	1/18	66.4	52.8	12.0	152.	71.5	1150.	2134.	0.44	0.50	2.4	0.003	0.04	0.09	32	23	1300.	5.6	2.6
	3/12	101	80.4	28.4	240.	144.	1094.	4258.	0.14	0.12	4.0	0.009	0.01	0.02	57	29	2490.	4.2	2.1
	4/9	68.0	58.4	6.2	8.3	1.2	—	42.4	0.08	nil	0.06	0.008	0.01	0.03	3.8	19	13.	0.47	0.18

APPENDIX "C"

CLARK HILL RESERVOIR

SUMMARY OF INDIVIDUAL RESULTS - IRON, MANGANESE, TEMPERATURE, TURBIDITY AND DISSOLVED OXYGEN DETERMINATIONS; RESERVOIR DISCHARGE DATA.

(NOT FOR PUBLIC RELEASE)
SAVANNAH RIVER STUDIES
ANALYTICAL RESULTS

CLARK HILL RESERVOIR
S-255
Ga.Hwy #43 Bridge over Savannah River

DATE	DEPTH FT.	MANG-ANESE ppm	IRON ppm	TEMP. DEG.C.	TURB. ppm	DISS. OXYGEN ppm	DIS-CHARGE SEC-FT.	DATE	DEPTH FT.	MANG-ANESE ppm	IRON ppm	TEMP. DEG.C.	TURB. ppm	DISS-OXYGEN ppm	DIS-CHARGE SEC-FT.
4/30/52	Total 35'						14,200								
"	32'	—	—	19'	90	8.2									
"	10'	0	0.04	19	80	8.3									
5/19/52	Total 33'						4,050								
"	30'	0.007	0.20	24	3	8.9									
"	3'	—	—	27	2	9.1									
5/22/52	Total 25'						4,080								
"	23'	0.0013	0.04	24	4	5.6									
"	3'	—	—	26	2	7.6									

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CLARK HILL RESERVOIR
S-253, Li(S.C.)-3.2
S.C.Hwy #43 Bridge over Little River, S.C.

SAVANNAH RIVER STUDIES
ANALYTICAL RESULTS

DATE	DEPTH FT.	MANGANESE ppm	IRON ppm	TEMP. DEG.C.	TURB. ppm	DISS. OXYGEN ppm	DISCHARGE SEC.FT.	DATE	DEPTH FT.	MANGANESE ppm	IRON ppm	TEMP. DEG.C.	TURB. ppm	DISS-OXYGEN ppm	DISCHARGE SEC-FT.
4/30/52	Total 20'						14,200								
"	17'	0	0.068	19	65	7.6									
"	5'	0	0.068	20	60	7.7									
5/19/52	Total 23'						4,050								
"	20	0.007	0.32	23	5	6.5									
"	3'	—	—	30	5	9.5									
5/22/52	Total 18'						4,080								
"	15'	0.0013	0.048	21	410	6.1									
"	3'	—	—	25	300	6.2									

(NOT FOR PUBLIC RELEASE)
SAVANNAH RIVER STUDIES
ANALYTICAL RESULTS

CLARK HILL RESERVOIR
S - 246
8 miles above Dam

DATE	DEPTH FT.	MANGANESE ppm	IRON ppm	TEMP. DEG.C.	TURB. ppm	DISS. OXYGEN ppm	DISCHARGE SEC-FT.
5/6/52	Total 83'						9,450
"	80'	0.867	0.10	18	10	4.9	
"	30'	—	—	21	37	6.9	
"	5'	—	—	26	4	8.5	
5/13/52	Total 75'						7,100
"	72'	0.040	0.16	20	6	7.4	
"	48'	0.133	0.24	20	12	—	
"	23'	—	—	21	2	—	
"	3'	—	—	22	3	7.5	
5/21/52	Total 68'						4,070
"	65'	0.005	0.048	20	5	4.6	
"	40'	0.12	0.10	21	3	3.2	
"	15'	—	—	25	2	7.8	
"	3'	—	—	26	1	7.9	
5/26/52	Total 75'						4,085
"	72'	0.44	0.048	21	6	0.27	
"	47'	0.30	0.02	22	<1	2.6	
"	22'	—	—	25	<1	7.1	
"	3'	—	—	26	1	7.6	

(NOT FOR PUBLIC RELEASE)
SAVANNAH RIVER STUDIES
ANALYTICAL RESULTS

CLARK HILL RESERVOIR
S-239.1,Li(Ga)-9
Ga.Hwy #47 Bridge over Little River,Ga.

DATE	DEPTH FT.	MANGANESE ppm	IRON ppm	TEMP. DEG.C.	TURB. ppm	DISS. OXYGEN ppm	DISCHARGE SEC-FT.
4/30/52	Total 65'						14,200
"	63'	0.78	0.12	16	40	2.4	
"	40'	0.053	0.24	15	25	5.2	
"	5'	—	—	21	13	8.3	
5/19/52	Total 72'						4,050
"	69'	0.67	0.28	18	15	0	
"	44'	0.0047	0.24	20	8	2.4	
"	19'	0.0013	0.048	22	4	7.8	
"	3'	—	—	24	4	8.2	
5/22/52	Total 72'						4,080
"	70'	1.33	0.13	17	32	0	
"	45'	0.04	0.52	19	10	2.3	
"	20'	0.0013	0.040	21	4	5.8	
"	3'	—	—	25	3	7.9	

(NOT FOR PUBLIC RELEASE)
SAVANNAH RIVER STUDIES
ANALYTICAL RESULTS

CLARK HILL RESERVOIR
1 mile above Dam - Junction of Little River, Georgia with the Savannah River
S-239.1

DATE	DEPTH FT.	MANGANESE ppm	IRON ppm	TEMP. DEG.C.	TURB. ppm	DISS. OXYGEN ppm	DISCHARGE SEC-FT.
3/10/52	Total 98'						22,850
"	78'	0.012	0.55	10	—	9.5	
"	48'	0.009	0.42	10.5	—	9.9	
"	23'	0.002	0.54	10.5	—	10.0	
3/31/52	Total 130'						31,000
"	100'	0.019	0.12	12.5	98	7.18	
"	75'	0.010	0.07	13.0	175	8.2	
"	50'	0.0063	0.13	13.0	185	8.6	
"	25'	0.010	0.08	14.0	165	8.8	
"	3'	0.0010	0.10	14.0	140	8.8	
5/1/52	Total 118'						10,500
"	115'	0.93	0.16	16.5	800	0.33	
"	90'	0.053	0.35	17.0	40	6.1	
"	65'			18.0		6.7	
"	40'			18.0		6.9	
"	15'			21.0		8.2	
5/6/52	Total 114'						9,450
"	111'	0.267	0.68	19	27	0.20	
"	89'	0.0013	0.072	21	4	8.0	
"	64'	0.0013	0.048	19	8	6.7	
"	39'	—	—	19	3	6.20	
"	14'	—	—	24	2	7.9	
"	3'	—	—	26	1	8.4	
5/13/52	Total 96'						7,100
"	93'	0.053	0.08	19	8	7.8	
"	68'	0.047	0.14	19	6	7.9	
"	43'	0.0013	0.18	21	4	7.0	
"	18'	—	—	22	4	7.8	
"	3'	—	—	23	3	8.0	

(NOT FOR PUBLIC RELEASE)
SAVANNAH RIVER STUDIES
ANALYTICAL RESULTS

CLARK HILL RESERVOIR
1 Mile above Dam-Junction of Little River, Georgia, with Savannah River
S-239.1

DATE	DEPTH FT.	MANGANESE ppm	IRON ppm	TEMP. DEG.C.	TURB. ppm	DISS. OXYGEN ppm	DISCHARGE SEC-FT.	DATE	DEPTH FT.	MANGANESE ppm	IRON ppm	TEMP. DEG.C.	TURB. ppm	DISS. OXYGEN ppm	DISCHARGE SEC-FT
5/3/52	*115'			13		0.40	9,450								
	110'			13.5		0.68									
	95'			14		4.3									
	75'			15		6.6									
	50'			16		6.7									
	25'			19		7.8									
	10'			22		8.0									
	5'			24		8.3									

* Alkalinity 22.9 ppm. Samples collected and analytical determinations made at location by Dr. D. C. Scott and U. of Ga. Biology students.

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CLARK HILL RESERVOIR
1 Mile above Dam - Junction of Little River Georgia with the Savannah River
S-239.1

SAVANNAH RIVER STUDIES
ANALYTICAL RESULTS

DATE	DEPTH FT.	MANGANESE ppm	IRON ppm	TEMP. DEG.C.	TURB. ppm	DISS-OXYGEN ppm	DIS-CHARGE SEC-FT.	DATE	DEPTH FT.	MANGANESE ppm	IRON ppm	TEMP. DEG.C.	TURB. ppm	DISS. OXYGEN ppm	DIS-CHARGE SEC-FT.
5/21/52	Total 110'						4,070								
"	107'	0.80	0.08	17	30	0									
"	82'	0.0013	0.14	21	7	3.0									
"	57'	0.0013	0.06	20	3	4.6									
"	32'	—	—	22	3	6.5									
"	3'	—	—	25	4	7.9									
5/26/52	Total 115'						4,085								
"	113'	1.12	0.12	19	15	0									
"	88'	0.24	0.032	20	4	2.0									
"	63'	0.033	0.08	21	4	4.0									
"	38'	0.024	0.04	22	2	4.9									
"	13'	—	—	24	1	7.4									
"	3'	—	—	25	1	7.7									

(NOT FOR PUBLIC RELEASE)
SAVANNAH RIVER STUDIES
ANALYTICAL RESULTS

CLARK HILL RESERVOIR
One Mile Above Dam-Junction of Little River, Georgia with the Savannah River

DATE	DEPTH FT.	MANGANESE ppm	IRON ppm	TEMP. DEG.C.	TURB. ppm	DISS. OXYGEN ppm	DISCHARGE SEC.FT.	DATE	DEPTH FT.	MANGANESE ppm	IRON ppm	TEMP. DEG.C.	TURB. ppm	DISS. OXYGEN ppm	DISCHARGE SEC.FT.
6/13/52*	105			16.4	—	—	4,120	7/28/52	110			20.0		0*	3,510
	100			16.8	—	0.14			100			20.3		0*	
	90			17.5	<10	0.97			90			20.6		0*	
	80			18.5	<10	4.2			80			21.0		0*	
	70			18.9	<10	4.3			70			21.6		0*	
	60			19.6	<10	3.0			60			22.5		0*	
	50			20.0	<10	3.7			50			23.9		0*	
	40			20.8	<10	2.7,2.2			40			25.8		0*	
	35			21.5	<10	—			30			27.3		1.0	
	30			22.1	<10	3.2,2.9			20			28.6		6.4	
	25			23.3	<10	4.3			10			30.4		7.3	
	20			27.8	<10	7.6			0			31.7		7.0	
	15			28.1	<10	7.6									
	10			28.3	<10	8.2									
	5			28.6	<10	8.2									
	0			29.0	<10	8.1									

*Samples collected and determinations made at location

*Noticeable odor of H_2S present. The water leaving the reservoir gates had a distinct H_2S odor which was noticeable 2 miles upwind.

PROVISIONAL DATA

(NOT FOR PUBLIC RELEASE)
SAVANNAH RIVER STUDIES
ANALYTICAL RESULTS

CLARK HILL RESERVOIR
S-237.8
0.3 Mile below Clark Hill Dam
Sample taken from construction bridge below the dam

DATE	DEPTH FT.	MANGANESE ppm	IRON ppm	TEMP. DEG.C.	TURB. ppm	DISS. OXYGEN ppm	DISCHARGE SEC-FT.	DATE	DEPTH FT.	MANGANESE ppm	IRON ppm	TEMP. DEG.C.	TURB. ppm	DISS. OXYGEN ppm	DISCHARGE SEC-FT.
5/26/52	3'	0.60	0.04	27	8	9.2	4,085								

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APPENDIX "D"

SUMMARY OF INDIVIDUAL ANALYTICAL RESULTS FOR THE SAVANNAH RIVER SECTION S-23 to S-0

SAVANNAH RIVER STUDIES

Summary of Individual Analytical Results for the Savannah River Section, S-23 to S-2

March 28, 1952

	High Tide					Between Mean and High Tide				Mean Tide				Low Tide				
Time of Sampling	9:45 AM - 11:15 AM					11:25 AM - 12:55 PM				12:25 PM - 2:30 PM				4:00 PM - 5:49 PM				
Station	Chlorides ppm	Chlorides as % Sea Water	D.O. ppm	D.O. % Saturation	(M.O.) Alkalinity ppm	Chlorides ppm	Chlorides as % Sea Water	D.O. ppm	D.O. % Saturation	Chlorides ppm	Chlorides as % Sea Water	D.O. ppm	D.O. % Saturation	Chlorides ppm	Chlorides as % Sea Water	D.O. ppm	D.O. % Saturation	(M.O.) Alkalinity ppm
Surface Sample (3 feet below surface)																		
S-2	2,170	11	5.0	50	29	1,710	9	5.6	56	1,770	9	6.0	60	560	3	6.3	62	28
S-5	1,150	6	5.2	52	29	930	5	5.3	53	870	5	6.1	60	155	0.8	6.3	62	—
S-8	760	4	5.3	53	24	340	2	5.8	58	41	0.2	6.6	65	21	0.1	6.8	67	19
S-11	55	0.3	7.0	69	20	12	<0.1	7.2	71	9.7	<0.1	7.2	71	6.7	<0.1	7.3	72	16
S-14	4.4	<0.1	7.3	72	14	4.1	<0.1	7.3	72	3.6	<0.1	7.3	72	4.7	<0.1	7.4	73	14
S-17	3.4	<0.1	7.5	74	14	2.8	<0.1	7.5	74	3.3	<0.1	7.6	75	3.3	<0.1	7.6	75	13
S-20	2.4	<0.1	7.4	73	17	2.6	<0.1	7.5	74	3.3	<0.1	7.6	75	3.8	<0.1	8.3	82	13
S-23	3.3	<0.1	7.6	74	13	3.0	<0.1	7.7	76	3.3	<0.1	7.8	77	3.2	<0.1	7.7	75	13
Bottom Samples (3 feet above channel bottom, or top of sludge bank)																		
S-2	15,250	80	6.9	80	93	14,660	77	6.9	79	10,430	55	5.7	63	2,830	15	5.2	53	—
S-5	2,670	14	4.7	48	25	13,550	71	5.7	65	4,610	24	5.0	52	870	5	5.9	59	26
S-8	900	5	5.2	51	22	6,200	33	4.7	49	240	1	6.1	60	86	0.5	6.0	59	22
S-11	150	0.7	6.4	63	20	20	0.1	7.4	73	13	<0.1	3.0	30	15	<0.1	6.5	64	17
S-14	4.7	<0.1	7.3	72	14	4.2	<0.1	7.2	71	3.6	<0.1	7.4	73	4.2	<0.1	7.4	73	14
S-17	3.5	<0.1	7.6	75	19	3.2	<0.1	7.4	73	3.3	<0.1	7.6	75	3.5	<0.1	7.6	75	12
S-20	5.5	<0.1	7.6	75	24	3.0	<0.1	7.6	75	3.3	<0.1	7.6	75	3.9	<0.1	7.7	76	14
S-23	3.3	<0.1	7.7	76	16	3.3	<0.1	7.6	75	3.3	<0.1	7.6	75	3.4	<0.1	8.3	82	14

SAVANNAH RIVER STUDIES

Summary of Individual Analytical Results for the Savannah River Section, S-23 to S-0

June 23, 1952

Time of Sampling	High Tide (Falling) 9:07 AM to 10:19 AM					Low Tide (Rising) 3:25 PM to 5:04 PM				
Station	Temperature °C	Chlorides ppm	Chlorides as % Sea Water	D.O., ppm	D.O. % Saturation	Temperature °C	Chlorides ppm	Chlorides as % Sea Water	D.O., ppm	D.O. % Saturation
Surface Samples (3 feet below surface)										
S-0	30	15,440	81	3.8	58	30	9,100	48	5.2	76
S-2	30	12,340	65	5.4	81	30	6,280	33	4.2	58
S-5	30	9,480	50	5.0	72	30	4,480	24	3.5	48
S-8	30	6,480	34	3.5	49	30	2,350	12	2.8	38
S-11	30	4,220	22	2.6	36	30	1,560	8.2	4.3	58
S-14	29	1,570	8.3	2.2	29	30	80	0.4	3.5	46
S-17	29	390	2.1	1.4	19	30	7	0.04	5.7	74
S-20	30	11	0.1	4.6	60	30	5	0.03	6.6	86
S-23	30	5	0.03	6.4	83	30	--	--	6.7	88
Bottom Samples (3 feet above channel bottom, or top of sludge bank)										
S-0	30	17,930	94	5.7	90	29	16,700	88	5.2	80
S-2	30	13,100	69	5.7	86	29	15,920	84	4.9	75
S-5	30	16,560	87	5.0	79	29	14,200	75	4.0	60
S-8	30	12,500	66	4.2	63	29.5	8,570	45	2.9	42
S-11	30	11,460	60	3.1	46	29	2,670	14	1.9	26
S-14	29	3,710	20	1.8	24	29	910	5	1.5	19
S-17	29	1,650	8.7	1.0	13	29.5	21	0.1	5.6	73
S-20	29	12	0.1	4.0	52	29.5	7	0.04	6.6	85
S-23	29	5	0.03	6.2	80	29.5	--	--	6.7	87

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APPENDIX "D"

DESCRIPTION OF THE PROCEDURE USED

FOR

ASSAYING THE RADIOACTIVITY IN FRESH WATER

AND FOR BIOTA

Obviously, when dealing with low level radioactive samples in the order of the minimum detectable amount, the observed count, because of statistical fluctuations, may be lower than the observed background. This gives rise to negative radioactive values. This is to be expected and indicates that the precision of the determination is poor.

FRESH WATER PROCEDURE

The procedure used for assaying the radioactivity in fresh water was as follow

1. Suspended solids

   a. Filter 500 ml. of the well mixed water sample through a membrane filter */. Save the filtrate for Part 2. Allow the membrane plus the suspended solids to dry for several hours at room temperature before counting.

   b. Place the membrane filter in an aluminum dish. Insert an iron ring on the periphery of the filter to hold it flat. Insert sample into an internal proportional gasflow counter set at a voltage for alpha counting Flush with P-10 gas (90 percent Aragone-10 percent methane) and count for 16 minutes. Reset the instrument and count for an additional 16 minutes. If the 16 minute counts do not agree within the statistical error of counting, repeat the count. Repeat the counting procedure in an internal counter set at a voltage for beta counting. Correct for backscatter and geometry and convert the values to uuc/liter of water.

2. Dissolved solids

   a. Place aluminum dishes (48 mm. in diameter and 15 ml. in capacity) in an oven at 103° C. for two hours. Cool in a desiccator and weigh.

*/ Clark, H.F., Geldreich, E.D., Jeter, H.L., and Kabler, P.W. "Membrane Filter in Sanitary Bacteriology". Public Health Reports 66, 951 (1951).

b. Evaporate duplicate 200 ml. portions of the filtered sample from Part 1 in duplicate weighed aluminum dishes on a hot plate which has been adjusted to keep the temperature slightly under the boiling point of the water.

c. Dry the samples at 103-105°C. to constant weight.

d. Place dish in internal counters and count for two 16 minute periods at a voltage for alpha counting and again at the beta counting voltage as for suspended solids. Convert the alpha and beta counts to μμc/liter of water.

BIOTA PROCEDURE

The laboratory processing procedure is as follows: */

1. Fish Flesh

A composite sample of 10 fishes is dissolved in 50 ml. of 1:1 nitric acid. In the case of composite samples an aliquot equal to 1 to 2 grams of weighed fish, or in the case of an individual specimen 1 or 2 grams of weighed fish flesh is transferred to a 50 ml. Erlenmeyer flask with about 5 ml. of distilled water and 5 ml. of concentrated nitric acid. The sample is gradually heated to boiling on a hot plate and evaporated to dryness. About 10 ml. of

*/ It should be noted that the procedures adopted for low level assay of biological samples may cause the loss of some radioactivity such as carbon, iodine and gases. The loss of small amounts of this radioactivity is considered to be relatively unimportant from a public health standpoint. The results include natural potassium-40 which might conceivably increase the fish flesh beta radioactivity by as much as 3 μμc/g.

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concentrated nitric acid is added and the solution warmed to about 50°C. Hydrogen peroxide (30 per cent solution) is added dropwise, as required, to decolorize and promote wet oxidation. Digestion is continued at a gentle boiling temperature to dryness. The latter steps were repeated if necessary, until the residual solids in the flask are white and crystalline in nature. The acid digested mineral residue represents one to two per cent of the weight of the flesh. The residue is dissolved in a known volume of 0.5 milliequivalents of nitric acid and 7 to 10 ml. of water. It is convenient to prepare this clear digestate volume so that 2 ml. contains 0.2 or 0.4 gram of original tissue. A sample for counting is then prepared by compositing 2 ml. from each of two to five digestates in an aluminum dish and evaporating gently to dryness. The white crystalline solids are distributed fairly uniformly over the dish bottom. The sample is then counted for alpha and beta radioactivity as explained previously for water samples and reported in uuc/gram of original tissue. If the composite sample shows the presence of alpha or beta activity above a statistically normalized average, a sample of each of the digestates is deposited on an aluminum dish and counted separately.

2. Fish Bone

Bony tissue is removed from fish specimen, air dried, scraped free of flesh and stored in vials at the field laboratory and

shipped to Cincinnati. Preliminary determinations of these fish bone samples indicate a wide fluctuation in the moisture content, probably due to variable preparation, shipping and storage conditions. Consequently, composite samples of 5 to 10 grams of bone are ignited in a tared crucible at 450° C. for at least four hours, cooled and weighed. The ignited bone sample is then ground to a powder in a mortar. One gram of bone powder is transferred to an Erlenmeyer flask and dissolved in about 2 ml. of warm one molar nitric acid. After solution, the volume is diluted with water so that each ml. contains 5.0 mg. of bone ash. Five to 10 ml. of solution is transferred to an aluminum dish, evaporated gently to dryness and counted. Small samples of about one gram of bone are similarly ignited in a tared crucible, weighed and dissolved without grinding.

3. Brush Box Organisms and Algae

These samples are treated similarly to fish flesh samples. In general, the samples required longer periods of acid digestion and the residues are frequently colored and difficult to dissolve in dilute nitric acid after wet oxidation. Suspensions of the residue are transferred to aluminum dishes and counted.

APPENDIX "F"

CHEMICAL METHODS OF WATER ANALYSIS

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MANGANESE - COLORIMETRIC DETERMINATION

Manganese is readily determined in small concentrations by the colorimetric determination of permanganate formed by oxidation of the manganese with periodate in acidic solution.

1. Apparatus

1.1 Evaporation dishes 500 - 1000 ml. capacity

1.2 Nessler tubes for visual color comparison

2. Reagents

2.1 Sulfuric acid, Concd. reagent grade

2.2 Perchloric acid 70-72% reagent grade

2.3 Sodium paraperiodate

2.4 Phosphoric acid 6M

2.5 Manganous Sulfate standard solution. Dissolve 0.1438 of $KMnO_4$ in distilled water to which has been added 2-3 ml. of 2N H_2SO_4. Reduce by adding 0.4 gm. of $NaHSO_3$. Boil off excess SO_2 and dilute to one liter with distilled water.

2.6 Sodium paraperiodate - sulfuric acid reagent. Prepare a H_2SO_4 solu. by adding 120 ml. of conc. H_2SO_4 to 1500 ml. of distilled water and diluting to 2 liters. Add 2.4 gm. of $Na_3H_2IO_6$ heat to boiling and place for 30 minutes, in a boiling water bath.

2.7 Manganese color standard. Add 1.2 ml. of conc. H_2SO_4 and 30 ml. of sodium paraperiodate-sulfuric acid reagent to exactly 20.0 ml. of standard $MnSO_4$ solu. After thoroughly mixing, add 0.3 gm. of solid $Na_3H_2IO_6$, heat to boiling

and place for 30 minutes in a boiling water bath. Cool and dilute to one liter with H_2SO_4 reagent. This standard contains 0.001 mg. of permanganate manganese per ml. Prepare a series of color standards in accordance with Table 10, page 57, 9th Edition, Standard Methods.

2.8 Nitric Acid, Conc. reagent grade

2.9 Aluminum hydroxide suspension.

3. Preparation of Sample

Turbid and colored samples should be clarified with aluminum hydroxide in order to obtain values for manganese in solution only. Method of preparation of aluminum hydroxide appears on page 74, 9th Edition of Standard Methods for the Examination of Water and Sewage.

Aluminum hydroxide, at the rate of about 10 ml. per liter of sample, is added, well mixed, and then allowed to settle. The suspension is filtered. If a clear and colorless solution is not obtained, the process is repeated.

4. Procedure

To a portion of sample containing 0 - 0.1 mg. of manganese, add 5 ml. of HNO_3 and evaporate on a steam bath or on a hot plate at just below the boiling point to a volume of 15-20 ml. Transfer the solution, together with any solids remaining in the dish, to a 125-ml. conical flask, add 5 ml. additional HNO_3 and 10 ml. of $HClO_4$ 70-72% and a few glass beads to prevent bumping. Evaporate on a hot plate until dense fumes

appear in the flask or until digestion is considered complete. The solution should be colorless. Repeat the addition of HNO_3 and $HClO_4$ if necessary. Cool the solution to room temperature, dilute to about 50 ml. with distilled water, boil to expel chlorine, then allow to cool. Filter through porcelain filter or paper into a 100-ml. volumetric flask, then make up to volume. Mix.

An aliquot of the acid-digested sample is placed into a 250-ml. conical flask and made up to a volume of about 50 ml. with distilled water. Add 20 ml. H_3PO_4 5N, 1 ml. H_2SO_4 conc. and 0.3 grm. $Na_3H_2IO_6$. Then heat the solution to boiling and keep just below boiling for 30 minutes. Cool to room temperature, then transfer the solution to a 100 ml. Nessler tube, make up to mark and compare with standards.

5. Calculations

$$\text{ppm Mn} = \frac{\text{mg. Mn in the matched standard} \times 1000}{\text{ml. sample}}$$

IRON - COLORIMETRIC DETERMINATION
PHENANTHROLINE METHOD

Ortho-phenanthroline reacts with ferrous iron in dilute solution at a pH of 2.0 to 9.0 to give a pink to red color.

1. Apparatus

1.1 Nessler tubes for visual color comparison.

2. Reagents

2.1 Hydroxylamine hydrochloride. Dissolve 10 gm. NH_2OH in

90 ml. water. Prepare fresh every few days.

2.2 Iron standard solution. Dissolve 0.7022 gm. of $FeSO_4(NH_4)_2SO_4 \cdot 6H_2O$ in 50 ml. distilled water and 20 ml. concd. H_2SO_4 and dilute to 1 liter. One ml. of the solution contains 0.1 mg.Fe.

2.3 Iron standard solution 0.001 mg.Fe per ml. Prepare shortly before use by diluting 10 ml. of 2.2 to 1000 ml.

2.4 1.10- phenanthroline. Dissolve 0.5 gr. of the monohydrate in 500 ml. of water heated to 80-90°C.

2.5 Sodium acetate. Dissolve 200 gr. of sodium acetate in 800 ml. of water.

3. Preparation of Sample

Turbid and colored samples should be clarified with aluminum hydroxide in order to obtain values for iron in solution only.

4. Procedure

Place an aliquot of the sample into a 100 ml. Nessler tube. Add 1 ml. of NH_2OH and 10 ml. sodium acetate solution. Dilute to about 75 ml. and add 10 ml. 1,10- phenanthroline solution. Dilute to volume, mix, and compare after 10 minutes with standards. The standards are stable for six months.

5. Calculations

$$\text{ppm Fe} = \frac{\text{mg Fe in the matched Std} \times 1000}{\text{ml. sample}}$$

6. Suggested Standards

1 ml.	.001 mg.
2	.002
4	.004
6	.006
8	.008
10	.01
15	.015
20	.02

Notes and Comments

1. Digestion fumes can be controlled by inserting a small funnel into neck of Erlenmeyer flask.
2. Substitute nitric acid for perchloric acid in digestion and proceed as follows

   Acidify sample with5 ml. nitric acid, evaporate to 15-20 ml., transfer, together with any solids remaining in the dish, to a 125 ml. Erlenmeyer Flask, add 5 ml. additional nitric acid and 5 ml. sulfuric acid. Evaporate on a hot plate until dense white fumes of SO_3 appear.
3. Convenient sample size for digestion is 500 ml. Use the major portion for the determination of manganese and the remaining for iron.
4. Standards for both manganese and iron are stable for at least six months.

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APPENDIX "C"

BIOLOGICAL METHODS AND TABLE

(COMPLETE LIST OF ORGANISMS

FOUND IN BRUSH BOX SAMPLES)

PLANKTON COLLECTION AND COUNTING METHODS

Plankton samples were collected with a two-liter Kemmerer bottle, and were concentrated by pouring them through a standard Wisconsin plankton net. The concentrates were washed from the bucket of the plankton net with distilled water and preserved in the field with formalin. Nannoplankton was sampled by saving 500 milliliters of the filtrate from the plankton net and preserving it in the field with formalin. The nannoplankton samples were later concentrated in the laboratory by use of a Foerst plankton centrifuge. The net plankton samples were counted by examining the entire contents of a one-milliliter Sedgwick-Rafter counting cell at a magnification of 100 diameters. The nannoplankton samples were counted by the use of the Sedgwick-Rafter counting cell and Whipple ocular micrometer at a magnification of 210 diameters. The number of Sedgwick-Rafter cells or Whipple fields counted for each sample depended upon the abundance of organisms in the sample. The net and nannoplankton counts were expressed as organisms per liter.

BOTTOM ORGANISM COLLECTION METHODS

Petersen Dredge

Samples were obtained with a Petersen Dredge lowered from a swivelled winch and boom mounted on a fourteen-foot boat. The Petersen Dredge samples an area of about .08 square meter, but the volume of materials taken varies greatly depending upon the character of the bottom and how completely the dredge fills. It was found most practicable to use the dredge without additional weights, even in swift water. Each sample consisted of 2 to 4 effective grabs with the dredge, taken

from as near the same spot as was possible while drifting the boat with the current. Incomplete samples, obtained when the jaws of the dredge were held apart by a stick or other object, were discarded. The bottom materials from each location were deposited in a wash tub and were washed through a series of nesting screens, the finest of which had a mesh size of 40 openings per inch. Each screen was washed thoroughly with a bucket pump and hose and the organisms retained by it were removed and preserved. No attempt was made to recover organisms which passed through the finest screen.

Brush Boxes

These consisted of 16" cubes of 1/2" mesh hardware cloth supported on the inside by a wooden frame. This size was chosen as one which would give an adequate sample, and would still fit into the top of a square wash tub. The boxes were floored inside with a piece of bronze window screening to prevent the escape of organisms as the boxes were being raised. A quantity of sticks, roots, and other natural debris, together with enough stones to make it sink, was placed inside the box. The top was wired down in such a manner that it could be easily opened again to remove the contents. Brush boxes were placed in situations from which samples were desired and allowed to remain for varying lengths of time. Upon removal from the water, the boxes were placed in tubs and washed thoroughly with a jet of water. The wash water was then strained through the same series of screens used for handling bottom samples and the organisms were treated in essentially the same manner as those from bottom samples. If convenient, the washing and screening was

done with tap water at the Augusta laboratory, but boxes from stations remote from the laboratory were washed and screened in the field with the aid of a bucket pump. In either case, when the fine mesh screen retained a very large amount of finely divided material and small organisms, these were preserved with formalin and carefully sorted in white enameled trays in the laboratory.

TABLE I -- Appendix "G"

COMPLETE LIST OF ORGANISMS

FOUND IN BRUSH BOX SAMPLES

TABLE I (Appendix "G") SAVANNAH RIVER STUDIES July 1951-July 1952

COMPLETE LIST - Brush Box Sampling - Numbers of Organisms

Location (River Mi.)	S-223.15	S-219.0				
Date Removed	8/24/51	7/30/51	8/6/51	8/13/51	8/20/51	10/16/51
No. of days in place	21	7	14	21	28	21
PORIFERA						
Spongilla fragilis						
TURBELLARIA						
Dugesia tigrina					1	
Undetermined						
ROTATORIA						
Floscularia sp.	Pr.*			Pr.	Pr.	
BRYOZOA						
Plumatella repens				Pr.		
ANNELIDA:OLIGOCHAETA						
Aulophorus furcatus					1	
Peloscolex sp.						
Undet. Naididae						
Undet. Tubificidae						
Undetermined	8			2	8	
ANNELIDA:HIRUDINEA						
Undet. Glossiphoniidae						
Undet. Erpobdellidae						
Helobdella sp.						
Undetermined	3					
ARTHROPODA:CRUSTACEA						
Copepoda:*Cyclops* sp.						
Ostracoda:*Cypris* sp.,						
Cypridopsis sp.	145			6	10	43
Isopoda:*Asellus militaris*						
Mancasellus sp.						
Amphipoda:*Hyalella azteca*						
Decapoda:*Macrobrachium ohione*						
Palaemonetes paludosus						1
ARTHROPODA:ARACHNIDA						
Hydracarina:*Albia* sp.*Arrenurus* sp.						
Libertia sp.*Neumania*						
Undetermined	13					

* = Present

(continued)

BLE I (Appendix "G") SAVANNAH RIVER STUDIES July 1951-July 1952
(continued)
COMPLETE LIST - Brush Box Sampling - Numbers of Organisms

S-215.5			S-213.3	S-203.3	S-201.55		S-172.0
8/27/51	9/19/51	10/16/51	9/19/51	8/27/51	8/28/51	7/27/52	9/4/51
21	21	21	21	21	22	165	21
						Pr.	
	9	1	238		12	174	
Pr.*	Pr.	Pr.	Pr.	Pr.	Pr.	Pr.	
						Pr.	Pr.
			50				
					6	3	
			12	3	8	396	
			22			13	
1	3		9		1	3	
16	79	1	20	3			
	3		5		4	3	

* = Present

(continued)

TABLE I (Appendix "G") SAVANNAH RIVER STUDIES July 1951-July 1952
(continued)
COMPLETE LIST - Brush Box Sampling - Numbers of Organisms

Location (River Mi.)	S-171.7	S-171.6	S-171.52		S-171.15	S-165.	
Date Removed	10/3/51	12/20/51	10/4/51	10/31/51	9/4/51	9/4/51	7/17
No. of days in place	21	37	22	26	21	21	139
PORIFERA							
Spongilla fragilis							Pr
TURBELLARIA							
Dugesia tigrina		1		1	4		
Undetermined							
ROTATORIA							
Floscularia sp.			Pr.		Pr.		
BRYOZOA							
Plumatella repens				Pr.		Pr.	
ANNELIDA:OLIGOCHAETA							
Aulophorus furcatus							
Peloscolex sp.							
Undet. Naididae							
Undet. Tubificidae					1	1	
Undetermined							60
ANNELIDA:HIRUDINEA							
Undet. Glossiphoniidae					1		
Undet. Erpobdellidae							
Helobdella sp.							
Undetermined							
ARTHROPODA:CRUSTACEA							
Copepoda:*Cyclops* sp.							
Ostracoda:*Cypris* sp.,						1	
Cypridopsis sp.							
Isopoda:*Asellus militaris*		3					
Mancasellus sp.				1			
Amphipoda:*Hyalella azteca*							
Decapoda:*Macrobrachium ohione*	1						
Palaemonetes paludosus							
ARTHROPODA:ARACHNIDA							
Hydracarina:*Albia* sp.*Arrenurus* sp.							
Libertia sp.*Neumania*							
Undetermined	1		5				1

* = Present

(continued)

TABLE I (Appendix "G") SAVANNAH RIVER STUDIES July 1951-July 1952
(continued)
COMPLETE LIST - Brush Box Sampling - Numbers of Organisms

S-160.75	S-155.25	S-155.2 St. 0.0	S-155.17	S-146.4	S-144.7	S-136.6	S-51.0
11/2/51	10/1/51	9/26/51	9/6/51	10/11/51	10/11/51	2/6/52	7/31/52
32	24	20	22	21	21	53	160
1		7		3			
		1					
Pr.*							Pr.
Pr.							
3	1	4					
1			2				
2							5
		1		1			
		1					
						2	
		1					
		13		6			
				1			
2						1	
2	2	6		33		8	

* = Present

(continued)

TABLE I (Appendix "G") SAVANNAH RIVER STUDIES July 1951-July 1952
(Continued)
COMPLETE LIST - Brush Box Sampling Numbers of Organisms

Location (River Mi.)	S-223.15	S-219.0				
Date Removed	8/24/51	7/30/51	8/6/51	8/13/51	8/20/51	10/16/51
No. of days in place	21	7	14	21	28	21
ARTHROPODA: INSECTA						
Plecoptera: Pteronarcys pictetii						
Taeniopteryx lita						
Nemoura sp.						
Allocapnia sp.						
Neoperla clymene						
Acroneuria abnormis						
Acroneuria arenosa						
Acroneuria georgiana						
Acroneuria mela						
Undet. Acroneuria						
Phasganophora capitata						
Paragnetina kansensis						
Undet. Perlidae						
Isoperla sp.						
Undet. Chloroperlidae						
Undetermined						
Ephemeroptera: Hexagenia sp.	3					
Tortopus sp.						
Neoephemera youngi						
S. pulchellum gr. 1	3	17	23	41	50	45
Stenonema exiguum, S. interpunctatumga, Undet. S.						
Heptagenia julia(?), H. pulla(?) Undet. H.						
Undet. Heptageniidae						
Undet. Ametropinae						
Isonychia spp.						
Paraleptophlebia sp.						
Ephemerella trilineata (?)						
Ephemerella invaria gr. nr. dorothea						
Undet. Ephemerella						
Caenis spp.	21		1		2	10
Tricorythodes albidineatus, 1 sp.	1	29	25	10	29	1
Baetis spinosus			1			
Baetis sp.						2
Undet. Baetinae						

(continued)

TABLE I (Appendix "G") SAVANNAH RIVER STUDIES July 1951-July 1952
(continued)

COMPLETE LIST - Brush Box Sampling - Numbers of Organisms

S-215.5			S-213.3	S-203.3	S-201.55		S-172.0
8/27/51	9/19/51	10/16/51	9/19/51	8/27/51	8/28/51	7/27/52	9/4/51
21	21	21	21	21	22	165	21
			1				
1	1			12	2	2	34
							2
	1						
10	5			1	68		1
							1
		1			1		1

(continued)

TABLE I (Appendix "G") SAVANNAH RIVER STUDIES July 1951-July 1952
(Continued)
COMPLETE LIST - Brush Box Sampling Numbers of Organisms

Location (River Mi.)	S-171.7	S-171.6	S-171.52		S-171.15	S-165.4	
Date Removed	10/3/51	12/20/51	10/4/51	10/31/51	9/4/51	9/4/51	7/17/
No. of days in place	21	37	22	26	21	21	139
ARTHROPODA: INSECTA							
Plecoptera: *Pteronarcys pictetii*		3					
Taeniopteryx lita		5		1			
Nemoura sp.							
Allocapnia sp.		2					
Neoperla clymene	2		3				
Acroneuria abnormis	14	1	8	9	7	3	
Acroneuria arenosa							
Acroneuria georgiana							
Acroneuria mela	1		6	1	3	1	
Undet. *Acroneuria*			1		4		
Phasganophora capitata		2					
Paragnetina kansensis	67	4	10	31	4	13	
Undet. Perlidae	3	23	9	7			
Isoperla sp.							
Undet. Chloroperlidae							
Undetermined							
Ephemeroptera: *Hexagenia* sp.							
Tortopus sp.							2
Neoephemera youngi				34			
S. pulchellum gr. 1	131	36	241	136	129	5	1
Stenonema exiguum, *S. interpunctatumga*, Undet. *S.*							
Heptagenia julia(?). *H. pulla*(?) Undet. *H.*		6	1	25			
Undet. Heptageniidae			95	21			
Undet. Ametropinae					1		
Isonychia spp.				1	5	2	
Paraleptophlebia sp.							
Ephemerella trilineata(?)		2		4			
Ephemerella invaria gr. nr. *dorothea*							
Undet. *Ephemerella*			3				
Caenis spp.	273	2	22	27	328	52	
Tricorythodes albidineatus, 1 sp.	72		22	6	62	10	
Baetis spinosus					2		
Baetis sp.							
Undet. *Baetinae*		1					

(continued)

TABLE I (Appendix "G") SAVANNAH RIVER STUDIES July 1951-July 1952
(continued)
COMPLETE LIST - Brush Box Sampling - Numbers of Organisms

S-160.75	S-155.25	S-155.2 St-0.0	S-155.17	S-146.4	S-144.7	S-136.6	S-51.0
11/2/51	10/1/51	9/26/51	9/6/51	10/11/51	10/11/51	2/6/52	7/31/52
32	24	20	22	21	21	53	160
			1		2		
						1	
						6	
6			4		10	2	
3	1		2		1		
						1	7
36	4		5		61	6	
	2		1	1	1	11	
						1	
						5	
			1				
1			1		1		
189	7		17	3	169	79	13
20			2		43	14	
3		1	1			15	
			1		12		48
1							
10					5	4	
						13	
						25	
63	146		32	2	240		82
26	15		27	2	43		11
4					1		
							1

(continued)

TABLE I (Appendix "G") SAVANNAH RIVER STUDIES July 1951-July 1952
(Continued)

COMPLETE LIST - Brush Box Sampling Numbers of Organisms

Location (River Mi.)	S-223.15	S-219.0				
Date Removed	8/24/51	7/30/51	8/6/51	8/13/51	8/20/51	10/16/51
No. of days in place	21	7	14	21	28	21
Odonata: *Gomphus dilatatus*						
Gomphus plagiatus						
Gomphus spiniceps						
Undet. *Gomphus*					2	1
Dromogomphus spinosus						
Dromogomphus spoliatus						
Undet. *Dromogomphus* ed						
Ophiogomphus sp.						
Boyeria vinosa						
Macromia sp.				1	1	1
Neurocordulia alabamensis						
N. molesta, *N. virginiems*	1	1	3	4	8	3
Undet. Cordulinae			1			1
Perithemis sp.						
Agrion sp.			1			
Hetaerina titia		1		1	2	2
Argia moesta putrida, *translata*, Undet. *A.* spp.	29	9	19	20	43	55
Enallagma antennatum, *E. signatum*	4					
Undet. Coenagrionidae		19				1
Neuroptera: *Sialis* sp.	1					
Corydalus cornutus						
Trichoptera: *Dolophilodes*						
Chimarra aterrima						
Phylocentropus sp.						
Neureclipsis sp.		1	10	12	12	6
Polycentropus sp.						
Psychomyia sp.						
Cyrnellus marginatus						
Psychomyiid genus A(Ross)				2	1	
Psychomyiid genus B(Ross)	5					
Undet. Psychomyiidae						
Potamyia flava						
Hydropsyche frison						
Hydropsyche orris						
Hydropsyche simulans						
Undet. *Hydropsyche*						
Cheumatopsyche sp.						
Macronemum carolina		6	1		10	7
Undet. Hydropsychidae						1
Ochrotrichia sp.						
Orthotrichia sp.						
Hydroptila sp.						
Undet. Limnophilidae						
Leptocella candida, *L.* genus A(Ross)		5	3		1	1

(continued)

TABLE I (Appendix "G") SAVANNAH RIVER STUDIES July 1951-July 1952
(continued)
COMPLETE LIST - Brush Box Sampling Numbers of Organisms

S-215.5			S-213.3	S-203.3	S-201.55		S-172.0
8/27/51	9/19/51	10/16/51	9/19/51	8/27/51	8/28/51	7/27/52	9/4/51
21	21	21	21	21	22	165	21
						6	
			1			3	
1	3	1			1	5	
4	7	10	9		5	2	8
			1				
	1						1
6	13	15	54	28	66	12	32
			1			2	1
							1
	5				66	1	8
					1		
4	14	1	124		38	10	
			21	2	6		
1	6	5			25	1	22
					2		
						2	
						2	

(continued)

TABLE I (Appendix "G") SAVANNAH RIVER STUDIES July 1951-July 1952
(Continued)
COMPLETE LIST - Brush Box Sampling Numbers of Organisms

Location (River Mi.)	S-171.7	S-171.6	S-171.52		S-171.15	S-165.4	
Date Removed	10/3/51	12/20/51	10/4/51	10/31/51	9/4/51	9/4/51	7/17/5
No. of days in place	21	37	22	26	21	21	139
Odonata: Gomphus dilatatus							
Gomphus plagiatus							
Gomphus spiniceps					1		2
Undet. Gomphus							
Dromogomphus spinosus							
Dromogomphus spoliatus					1		
Undet. Dromogomphus ed							
Ophiogomphus sp.			1				
Boyeria vinosa					1	3	
Macromia sp.							
Neurocordulia alabamensis							
N. molesta, N.virginiems	21		12	3	2	8	
Undet. Cordulinae			1		32	3	
Perithemis sp.							
Agrion sp.			1		1		
Hetaerina titia	1		1	1	9	4	1
Argia moesta putrida, translata, Undet. A. spp.	13		67	12	87	10	
Enallagma antennatum, E. signatum			4				
Undet. Coenagrionidae			1			1	1
Neuroptera: Sialis sp.							3
Corydalu cornutus	11	2	2	2	13	15	2
Trichoptera: Dolophilodes							1
Chimarra aterrima		7		31	1		
Phylocentropus sp.							2
Neureclipsis sp.	13	13	12	118	112	17	14
Polycentropus sp.		2					
Psychomyia sp.							
Cyrnellus marginatus							
Psychomyiid genus A(Ross)		1	16	9	2		
Psychomyiid genus B(Ross)							
Undet. Psychomyiidae						2	
Potamyia flava						46	
Hydropsyche frison	202		6,1P**	300	242	202	
Hydropsyche orris							
Hydropsyche simulans							
Undet. Hydropsyche	80,3P**	8	7,5P		253,1P	226,2P	
Cheumatopsyche sp.	1	8		26	1		
Macronemus carolina	3107,2P	1	53	107	3484	2006	36,5
Undet. Hydropsychidae						113	
Ochrotrichia sp.							
Orthotrichia sp.							
Hydroptila sp.							
Undet. Limnophilidae				1			
Leptocella candida, L. genus A(Ross)	2		27	22	5	17	3

(continued)

** = Pupa

TABLE I (Appendix "G") SAVANNAH RIVER STUDIES July 1951-July 1952
(Continued)

COMPLETE LIST - Brush Box Sampling Numbers of Organisms

S-160.75	S-155.25	S-155.2	S-155.17	S-146.4	S-144.7	S-136.6	S-51.0
11/2/51	10/1/51	9/26/51	9/6/51	10/11/51	10/11/51	2/6/52	7/31/52
32	24	20	22	21	21	53	160
							3
	2						
			3				1
			1				
				1			
12	4		11				19
	1		5				
			3				1
19	27	17	15	37	2	2	12
		7		1			
7			7		1	1	2
21			1			1	
564	3		21		8	4	76
			1		1		
				7			
		17					3
						1	
1	6		19		1		
6	17		87		15		62
						1	
						1	
69	41				30	46	
						1	183
1293	453		797	1	2144	15	447,3P**
1425	1		110		28		19
							2
53	1		5		22	10	47,2P

** = Pupa

(continued)

TABLE I (Appendix "G") SAVANNAH RIVER STUDIES July 1951-July 1952
(continued)

COMPLETE LIST - Brush Box Sampling Numbers of Organisms

Location (River Mi.)	S-223.15	S-219.0				
Date Removed	8/24/51	7/30/51	8/6/51	8/13/51	8/20/51	10/16/51
No.of days in place	21	7	14	21	28	21
Athripsodes nr.mentious						
Athripsodes transversus, A. sp.						
Deletis inconspicua	3		3		1	
Traienodes sp.				2		
Undet. Leptoceridae						
Brachycentrus numerosus						
Undetermined			4			
Hemiptera: Undet. Veliidae						
Coleoptera: Dineutes sp.						
Peltodytes sp.						
Hydrovatus sp.						
Undet. Dytiscidae						
Hydrochus sp.				1		
Berosus sp.						
Dryops sp.						
Helichus sp.						
Ancyronyx variegatus			3A*	1A	3A	1A
Macronychus glabratus	1A	6A	1,20A	8A	24A	28A
Stenelmis convexula, decorata	6A	6A	3A	1A	13A	1A
Simsonia sp.						
Undet. Elmidae						
Undetermined						
Diptera: Atherix variegata						
Simulium sp.						
Chaoborus punctipennis						
Ablabesmyia carnea						
Ablabesmyia monilis	28	24	109,3P**	122	169,4P	13
Ablabesmyia flavifrons, P. melanops	3		1			
Ablabesmyia pilosella						
Undet. Ablabesmyia						
Anatopynia dyari	1					
Procladius sp.						
Clinotanypus sp.						
Coelotanypus nr. concinna				5	14	
Corynoneura scutellata, C.spp.						
Thienemanniella sp.						
Brillia par						
Spaniotoma sens.lat.spp.			2	1	2	18,3P
Psectrocladius sp.						
Tanytarsus signatus flavellus			1P	5P	3P	4P
Tanytarsus dissimilis						
Tanytarsus sens.lat.spp.		1	12	18	9	9

* A = Adult ** P = Pupa

(continued)

TABLE I (Appendix "G") SAVANNAH RIVER STUDIES July 1951-July 1952
(continued)
COMPLETE LIST - Brush Box Sampling Numbers of Organisms

S-215.5			S-213.3	S-203.3	S-201.55		S-172.0
8/27/51	9/19/51	10/16/51	9/19/51	8/27/51	8/28/51	7/27/52	9/4/51
21	21	21	21	21	22	165	21
			1				
	3		1	2	16,28P		
1P**							
						1P	
							1
				1			
			2		3	39,8A*	
	1A					17	6A
		1P	2A		1A	2	10,21A
	2A	1A	2A		1A	2	3A
						1	
69	394,19P	12	987,3P	81	269,1P	104,4P	31
		1	1				
	2				2		
2			18,1P	4	5	23	
2			5	4	13		
1	6,1P	8,3P	2		17,1P	25,25P	

* A = Adult ** P = Pupa (continued)

TABLE I (Appendix "G") (continued) SAVANNAH RIVER STUDIES July 1951-July 1952

COMPLETE LIST - Brush Box Sampling

Numbers of Organisms

Location (River Mi.)	S-171.7	S-171.6	S-171.52		S-171.15	S-165.4	
Date Removed	10/3/51	12/20/51	10/4/51	10/31/51	9/4/51	9/4/51	7/17/
No. of days in place	21	37	22	26	21	21	139
Athripsodes nr.mentious							
Athripsodes transversus, A. sp.					1	2	
Deletis inconspicua	3		2	2	3	3	
Traienodes sp.			13	12	7	7	
Undet. Leptoceridae							
Brachycentrus numerosus		14		2	1		
Undetermined							
Hemiptera: Undet. Veliidae							
Coleoptera: Dineutes sp.							
Peltodytes sp.							
Hydrovatus sp.							
Undet. Dytiscidae							2A
Hydrochus sp.					8A		
Berosus sp.							
Dryops sp.							
Helichus sp.							1A
Ancyronyx variegatus	1,7A	3,7A	2A 2,10A	1,3A	6,8A	4A	
Macronychus glabratus	1,27A	3A	4,95A	5,29A	6,53A	17A	18,
Stenelmis convexula, decorata	9,62A	2,6A	1,406A	126A	8,14A	28A	3,
Simsonia sp.					1		
Undet. Elmidae						1	
Undetermined							
Diptera: Atherix variegata		11	1		1		
Simulium sp.		1			3		
Chaoborus punctipennis					6	3	
Ablabesmyia carnea						1	
Ablabesmyia monilis	6	1	1	3	88		41
Ablabesmyia flavifrons, P. melanops	45		4	8	14	7	2
Ablabesmyia pilosella	4		1		7		1
Undet. Ablabesmyia					8	2	5
Anatopynia dyari					7		
Procladius sp.				1	23		6
Clinotanypus sp.					1		
Coelotanypus nr.concinna	1				1		1
Corynoneura scutellata, C.spp.		1		1			
Thienmanniella sp.							
Brillia par		19		1	1		
Spaniotoma sens.lat.spp.	6	23		24,4P**	9	26	
Psectrocladius sp.							
Tanytarsus signatus flavellus				5P	1P		
Tanytarsus dissimilis							
Tanytarsus sens.lat.spp.	250		101	154	121	10	6

* A = Adult ** P = Pupa

(continued)

TABLE I (Appendix "G") SAVANNAH RIVER STUDIES July 1951-July 1952
(continued)

COMPLETE LIST - Brush Box Sampling Numbers of Organisms

S-160.75	S-155.25	S-155.2 St-0.0	S-155.17	S-146.4	S-144.7	S-136.6	S-51.0
11/2/51	10/1/51	9/26/51	9/6/51	10/11/51	10/11/51	2/6/52	7/31/52
32	24	20	22	21	21	53	160
			2				
1						6	1
4			4		3		11
							1
	2A*						
1A							
	1A	8A	15A		20A		31
7A		15A	1,66A	5A	23A	4,7A	173,13A
90A	3A		27A		106A	58A	14,11A
		1A		13,1A			
6	6	6			2		
3	2						
2			18				6
							1
				11			23
34	26		7		3	4	3
							1
11	8	11	27	16	2		
	1						
4	1	3	1		5		
13		1			1		
8	1	5		2	1	15	2
854	268	89	162	6	2050	2	21

* A = Adult

(continued)

TABLE I (Appendix "G") (continued) SAVANNAH RIVER STUDIES July 1951-July 1952

COMPLETE LIST - Brush Box Sampling Numbers of Organisms

Location (River Mi.)	S-223.15	S-219.0				
Date Removed	8/24/51	7/30/51	8/6/51	8/13/51	8/20/51	10/16/51
No. of days in place	21	7	14	21	28	21
Rheotanytarsus exiguus						1P**
Microspectra sp.						
Microtendipes pedellus						
Stenochironomus taeniopennis	36					
Stictochironomus nr. *flavicingula* johannsen						
Polypedilum fallar	2P		2	5	2	1
Polypedilum illinoiense						
Undet. *Polypedilum* spp.	13	4	42,2P	35	23	2
Endochironomus nigricans	8	1	24,1P	17	49,2P	44,1P
Endochironomus tendens						
Endochironomus quadri-punctatus						
Glyptotendipes lobiferus						52
Cryptochironomus stylifer	2			1		
Cryptochironomus sp.B. johannsen	5		8	1	6	1
Undet.*Cryptochironomus*						
Limnochironomus modestus	8		1	2	5	7,1P
Parachironomus tenuicaudatus						
Synchironomus sp.	1					
Chironomus plumosus, *Camptochironomus tentans*						
Chironomus riparius						
Undet. Chironomidae (17 spp. larvae, 9 spp. pupae)	2		1,5P	1P	2,1P	1,2P
Bezzia setulosa						
Undet. *Bezzia* sp.						
Palpomyia sp.						
Stilobezzia sp.						
Undet. Ceratopogonidae						
Limnophora sp.				3	1	
MOLLUSCA:GASTROPODA						
Physa sp.	2				2	
Gyraulus spp.					4	1
Undet.*Planorbidae*	2					
Ferrissia, sp.	1		1		7	
Campeloma sp.						

** P = Pupa

(continued)

TABLE I (Appendix "G") SAVANNAH RIVER STUDIES July 1951-July 1952
(continued)
COMPLETE LIST - Brush Box Sampling Numbers of Organisms

S-215.5			S-213.3	S-203.3	S-201.55		S-172.0
8/27/51	9/19/51	10/16/51	9/19/51	8/27/51	8/28/51	7/27/52	9/4/51
21	21	21	21	21	22	165	21
3	3,1P**		3	6	5	23	12
2	39	1	36	181	33	11	
	3		5	7			
			2		7	2	
32	4		2	29	1	9	3
						1	
8	53,7P		26,2P	3	169,26P	291,60P	
		4P		8	116		
			3				
						45	
1,5P	18,3P	4P	22,7P	1,1P	15,12P	2,8P	4
						7	
9	31	29	94	1	9	28	
17	54	69	20			4	
						17	
			7		1	2	
1		3					

** P = Pupa

(continued)

TABLE I (Appendix "G") (continued) SAVANNAH RIVER STUDIES July 1951-July 1952

COMPLETE LIST - Brush Box Sampling Numbers of Organisms

Location (River Mi.)	S-171.7	S-171.6	S-171.52		S-171.15	S-165.4	
Date Removed	10/3/51	12/20/51	10/4/51	10/31/51	9/4/51	9/4/51	7/17/
No. of days in place	21	37	22	26	21	21	139
Rheotanytarsus exiguus	85P**	28	24P	76P	4P		
Microspectra sp.		1					
Microtendipes pedellus							
Stenochironomus taeniopennis							
Stictochironomus nr. flavicingula johannsen							
Polypedilum fallar		4					
Polypedilum illinoiense					24	64	
Undet. Polypedilum spp.	303,14P	7	15	63	141,4P		1
Endochironomus nigricans		5			17	1	1
Endochironomus tendens							
Endochironomus quadri-punctatus					1		
Glyptotendipes lobiferus							
Cryptochironomus stylifer			1		6		1
Cryptochironomus sp. B. johannsen	1		2	1	31		1
Undet. Cryptochironomus						1	
Limnochironomus modestus	1		1,1P	2,2P			
Parachironomus tenuicaudatus							
Synchironomus sp.							
Chironomus plumosus, Camptochironomus tentans							
Chironomus riparius							
Undet. Chironomidae (17 spp. larvae, 9 spp. pupae)	2,2P	2,1P	1,1P	13,14P	17,10P		3,
Bezzia setulosa					1		
Undet. Bezzia sp.							
Palpomyia sp.					1		
Stilobezzia sp.							
Undet. Ceratopogonidae		1				1	1
Limnophora sp.						1	
MOLLUSCA: GASTROPODA							
Physa sp.			1				3
Gyraulus spp.							
Undet. Planorbidae							
Ferrissia, sp.							
Campeloma sp.							

** P = Pupa

(continued)

TABLE I (Appendix "G") SAVANNAH RIVER STUDIES July 1951-July 1952
(continued)
COMPLETE LIST - Brush Box Sampling Numbers of Organisms

S-160.75	S-155.25	S-155.2 St-0.0	S-155.17	S-146.4	S-144.7	S-136.6	S-51.0
11/2/51	10/1/51	9/26/51	9/6/51	10/11/51	10/11/51	2/6/52	7/31/52
32	24	20	22	21	21	53	160
							1P**
						1	8
70	106		105		269	4	
3				4		2	6
2		3		32	1		
1							
							1,1P
11		1					
1			2				
4P	24	7	2			6	5,1P
				1			
	3			1			
							1
		1					
3				2	9		
1			1				

** P = Pupa

(continued)

TABLE I (Appendix "G") SAVANNAH RIVER STUDIES July 1951-July 1952
(Continued)
COMPLETE LIST - Brush Box Sampling Numbers of Organisms

Location (River Mi.)	S-223.15				S-219.0	
Date Removed	8/24/51	7/30/51	8/6/51	8/13/51	8/20/51	10/16/51
No. of days in place	21	7	14	21	28	21
Pleurocera sp.						1
Somatogyrus sp.						
Amnicola spp.		3			7	12
Undet. Amnicolidae	3			2		
Undetermined						
MOLLUSCA:PELECYPODA						
Pisidium sp.						
Sphaerium sp.						
Musculium sp.						
Eupera sp.						
Undet. Sphaeridae					1	
Undet. Unionidae						
TOTAL ORGANISMS	365	133	337	332	536	386

(concluded below)

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Location (River Mi.)	S-171.7	S-171.6	S-171.52		S-171.15		S-165.4
Date Removed	10/3/51	12/20/51	10/4/51	10/31/51	9/4/51	9/4/51	7/17/52
No. of days in place	21	37	22	26	21	21	139
Pleurocera sp.							
Somatogyrus sp.							
Amnicola spp.				1			
Undet. Amnicolidae							
Undetermined					1		
MOLLUSCA:PELECYPODA							
Pisidium sp.							
Sphaerium sp.							
Musculium sp.							
Eupera sp.							
Undet. Sphaeridae							
Undet. Unionidae							1
TOTAL ORGANISMS	4851	270	1330	1491	5465	2943	237

TABLE I (Appendix "G") SAVANNAH RIVER STUDIES July 1951-July 1952
(continued)
COMPLETE LIST - Brush Box Sampling Numbers of Organisms

S-215.5			S-213.3	S-203.3	S-201.55		S-172.0
8/27/51	9/19/51	10/16/51	9/19/51	8/27/51	8/28/51	7/27/52	9/4/51
21	21	21	21	21	22	165	21
		3					
7	10	8					
9	64	169	1		1	22	
						2	
	1		5		9	67	
			6			3	
		1					
						2	
61	870	353	1835	371	1074	1510	204

(concluded below)

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S-160.75	S-155.25	S-155.2 St-0.0	S-155.17	S-146.4	S-144.7	S-136.6	S-51.0
11/2/51	10/1/51	9/26/51	9/6/51	10/11/51	10/11/51	2/6/52	7/31/52
32	24	20	22	21	21	53	160
13							
6							
3							
			1				
5171	1186	227	1625	193	5366	386	1386